A Methodology to Link Strategic Quality Requirements to Operational Activities in Manufacturing

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Declaration

The work described in this report is the result of my own investigations. All sections of the text and results that have been obtained from other work are fully referenced. I understand that cheating and plagiarism constitute a breach of University Regulations and will be dealt with accordingly.

Signed:

Gillian Cooke

Coventry University, 28th May 2010

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Abstract

Organisations can deploy Total Quality Management (TQM) through company quality programmes in order to achieve improved business performance. A review and analysis of TQM literature found that the areas of strategic quality management, quality practices and quality activities (tools and techniques) have evolved largely independently without relationships being established. Employee involvement (EI) is a key element of TQM yet the involvement of individuals in specific quality activities is an under-researched topic. The aim of this research is to propose a framework which links these areas and provides a methodology for manufacturing organisations to use to link quality activities to strategic quality requirements and therefore facilitate the management of their quality programme.

Exploratory case study research has underpinned the research methods adopted. Information about the deployment of TQM through quality programmes via quality practices and quality activities was gathered through interviews, documentation and surveys. Specific details regarding the actual quality activities engaged in by individuals were obtained by participant observation. The data was evaluated both within case and cross case using a selection of methods.

Findings have resulted in the creation of two unique frameworks. The first, the Quality Programme, Quality Activities and Performance (QPQAP) framework, provides a structure to link strategic quality requirements to quality activities via performance measures and includes a feedback process to facilitate continuous improvement and sustain the quality programme. Quality Function Deployment (QFD) has been adapted to deploy the QPQAP Framework and an analysis process developed. The second framework describes an Activity Classification System (ACS) that can be used to categorise and analyse an individual's day-to-day quality activities and judge the application and effectiveness of these activities. Combined, these frameworks provide a Quality Programme Management Framework which enables organisations to make decisions about the application of quality activities and adjustments necessary to improve performance and fulfil strategic quality requirements.

Theoretical testing of the QPQAP Framework has found that it can be used to identify the quality activities needing interventions in order to fulfil the desired strategic quality requirements. The ACS appears suitable for categorising quality activities though requires validation in different manufacturing environments. This exploratory research has identified hypotheses and research questions for each of the frameworks to guide further research. In particular, longitudinal case studies are proposed to study the application of the models independently and combined as the Quality Programme Management Framework. Finally these Frameworks are an original contribution to the TQM literature through the use of QFD to manage quality programmes and a system for evaluating the quality activities deployed by shop floor employees.

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List of Acronyms

ACS ..... Activity Classification System

BS ..... British Standard

BSC..... Balanced Scorecard

CoQ..... Cost of Quality

CI..... Continuous Improvement

DT ..... Direct Time

EFQM ..... European Foundation for Quality Management

EI..... Employee Involvement

EQA..... European Quality Award

HK ..... Hoshin Kanri (Policy Deployment)

HoQ..... House of Quality

HR ..... Human Resources

ISO ..... International Standardisation Organisation

IT ..... Indirect Time

MBNQA ..... Malcolm Baldridge National Quality Award

NQA..... National Quality Award

PMP..... Performance Measurement Planning

POP..... Performance Objectives Planning

QAP..... Quality Activity Planning

QFD ..... Quality Function Deployment

QPQAP..... Quality Programme Quality Activities and Performance

SPC..... Statistical Process Control

SQM ..... Strategic Quality Management

SRP..... Strategic Requirements Planning

TPM..... Total Productive Maintenance

TQM ..... Total Quality Management

5S ..... Workplace organisation methodology (sorting, straightening,

..... sweeping, standardising and sustaining)

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1.1 Introduction

1.1.1 Overview

Total Quality Management (TQM) has long been recognised as an approach to increase an organisations competitiveness and profitability (Mehra *et al* 2001, Beheshti and Lollar 2003, Klefsjo *et al* 2008). Numerous authors (including Easton and Jarrell 1998, Lau and Idris 2001, Lee *et al* 2001, Lee 2002, Joseph *et al* 1999, Sun 2000, Sharma and Gadenne 2001, Mann and Kehoe 1994, Antony *et al* 2002) support this view and argue that TQM and its associated practices enhance business performance and lead to increased organisational effectiveness in a continuing drive to satisfy customers with better quality products and services. Implementing TQM will encourage business practices that lead to competitive advantages through increasing customer satisfaction, reducing costs, increased productivity, improved communication and employee involvement. These are some of the reasons that manufacturing organisations have implemented TQM through company quality programmes.

TQM has been in existence since the 1980's (McAdam 2000) and in this time a number of methods have emerged to support this approach including: Continuous Improvement, Kaizen, Six Sigma, Lean Sigma, Benchmarking, Business Process Re-engineering, Quality Awards/Excellence Frameworks, ISO9000 (and integrated management systems), Strategic Quality Management. Many of these approaches complement and overlap with TQM yet are substantial disciplines and research topics in their own right. TQM is a broad topic covering many themes which emphasise customer satisfaction, continuous improvement and employee involvement. It is believed that by adopting certain practices and principles, it offers a sustainable, better way of doing business (van der Wiele and Brown 2002). Therefore, previous research has focused on establishing what these practices may be and their implementation.

Research has reported on the key concepts and critical success factors of TQM, yet the quality practices identified are generic in nature, for example, leadership, top management support, customer focus, supplier focus. It has been reported that none of the research is in agreement with regard to the practices which comprise TQM and due to gaps in their coverage of TQM, further research into TQM theory has been advocated (Behara and Gunderson 2001). The adoption of different quality practices to suit different organisational contexts has been advocated (Mann and Kehoe 1994, Thiagaragan *et al* 2001, Boaden 1997). Research is continuing to examine and articulate the practices with a focus on developing TQM frameworks suitable for different contexts (for example; country, industry), frameworks to facilitate implementation, and establish the relationships between the practices and their effect on performance.

The link between quality practices and performance (quality and business) remains of interest particularly to determine the critical practices to achieve improved performance. Davies and Kochhar (2002) concluded it is necessary to improve overall performance and not just improvement in one specific area and when evaluating best practices a holistic approach is required which considers relationships between practices and over a period of time the impact of practices on performance. The issue has been pertinent for a while as research (Hendricks and Singhal 1997) suggested significant interest exists in trying to determine the best or effective practices for improving performance. Yet despite the long term recognition and interest in this topic (both in manufacturing generally and more specifically within TQM) the academic research to date has not identified which practices an organisation should engage in and neither has it determined a method for establishing whether practices are indeed best or effective.

Quality tools and techniques are used by organisations within a quality programme (as part of TQM) to aid the quality improvement initiatives that support Continuous Improvement (CI). However, the usage of tools and techniques is varied; their relationship within TQM frameworks and to quality practices is unclear. Quality tools and techniques are deployed by employees in order to improve quality performance. Research (Irani *et al* 1997) has long recognised that TQM will "influence working practices of employees" yet the nature of this influence and the effect on individuals' day-to-day working practices has not been established. Employee Involvement (EI) and participation are key elements within TQM (van der Wiele and Brown 2002) but research has failed to establish approaches for encouraging participation (Tonnessen 2005) or determine exactly what individuals should do in order to contribute to TQM and improved performance.

1.1.2 Challenges and Opportunities

Despite the widespread acclaims for TQM improving performance, particularly in award winning organisations (Forker *et al* 1996, Kumar *et al* 2008), there is wide variation in TQM results achieved by organisations (Lau and Idris 2001) and it has also been reported that in some cases implementing TQM is difficult and programmes do not achieve improved performance and even fail entirely (Prajogo and Sohal 2004). Possible reasons for failure are a lack of agreed theoretical foundation, failure to acknowledge the context specific nature, and difficulties with implementation (Klefsjo *et al* 2008). In addition TQM frameworks tend to view performance as an output rather than a component and it is argued that the link between quality and performance is company specific (Idris and Zairi 2006). Therefore manufacturing organisations need quality programmes which can be designed and implemented to fulfil their unique performance requirements.

The lack of theoretical foundation has led to the creation of models which differ in terms of terminology and content. Research which has investigated quality practices to articulate TQM and enable implementation has established a different set of components, as not only have the practices been articulated differently but the context under investigation has varied. This has also meant that investigations into relationships between the practices and to performance have produced different results. This complex situation does not help manufacturing organisations to understand which practices to implement and areas to focus on to support the quality programme (Sharma and Kodali 2008).

Although quality activities (tools and techniques) are the mechanism by which continuous improvement and employee involvement are integrated into the quality programme, research has not investigated the relationships between activities, practices, the quality programme more generally and performance. Therefore, this inhibits the selection of activities to meet the quality programme aims and whilst these decisions are company specific, a mechanism for their evaluation and comparison is required. Research (Beheshti and Lollar 2003, Tegarden *et al* 2003) has acknowledged that it is necessary to involve employees from all organisational levels in order to increase participation and involvement. The development of tools and techniques to increase participation is required (Tonnessen 2005). Consequently, an investigation into the application of quality activities by individuals would reveal not only the extent of employee involvement but also the extent of usage of quality tools and techniques.

Managing the quality activities performed by individuals could enable organisations to meet the quality programme aims and achieve improved performance. In order to do this connections between the quality programme requirements, quality practices, quality activities and performance needs to be established. In addition consideration of the dynamic nature of this process is required, since continuous improvement is a fundamental ingredient of a sustainable quality programme.

Therefore, there is a need for a framework which addresses all these shortcomings. In particular, it needs to address the context specific requirements. The “essence of capability, knowing what to do and why” (Ketokivi and Schroeder 2004) needs to be addressed from a quality perspective so that a company’s quality management programme can provide capability, ensuring that quality practices and activities deliver the desired performance and that continuous improvement can be sustained. Such a framework needs to enable organisations to evaluate their performance and take appropriate actions to make improvements so that competitiveness can be achieved.

1.1.3 General Approach

This research will adopt a practitioner focused perspective of TQM and examine quality programmes, quality practices and quality activities to look at the relationships between these three components and determine their connections. Research examining relationships has tended to follow a quantitative approach and used modelling techniques. However it has only been used to look at the relationships between practices. There is a need to look beyond practices and examine all aspects of a quality programme, from the senior management leading the programme to the individuals engaged in it. Research of this nature has largely followed a qualitative case study based approach and there has been an increase in research using multiple case studies and following a grounded theory orientated approach to data analysis. Therefore this type of approach will be followed.

This research will focus on the UK manufacturing sector and specifically focus on the deployment of quality within the manufacturing area. The manufacturing personnel on the shop floor will be of particular interest in order to evaluate employee participation and involvement in quality activities.

Finally, the general aim of this research is to provide management with a framework which will help them establish the effectiveness of the quality activities and enable their management, in line with the purpose of the organisations quality programme.

1.2 Research Aim and Objectives

The project aim is to develop a framework(s) and supporting methodology that enables manufacturing organisations to manage their quality programmes to achieve improved performance through the quality activities performed by individuals.

Addressing the following objectives will fulfil the aim:

- Reviewing existing literature and theory to determine key elements of quality programmes (TQM) and the relationship to the quality activities individuals in manufacturing organisations are engaged in.
- Examining best practice organisations to establish linkages between quality programmes, quality practices, quality activities and quality performance.
- Investigating the specific quality activities actual manufacturing personnel are engaged in.
- Developing a methodology to enable quality programme aims to be mapped to specific quality activities.

- Creating a methodology to identify the quality activities performed by manufacturing personnel in order to facilitate the selection/deployment of day-to-day quality activities.
- Developing a framework which will enable organisations to manage their quality programmes to achieve improved performance through the management of the quality activities performed by individuals in manufacturing.

In order to complete these objectives two research streams have been followed and in order to facilitate clarity when reading this thesis these have been illustrated (Figure 1.1).

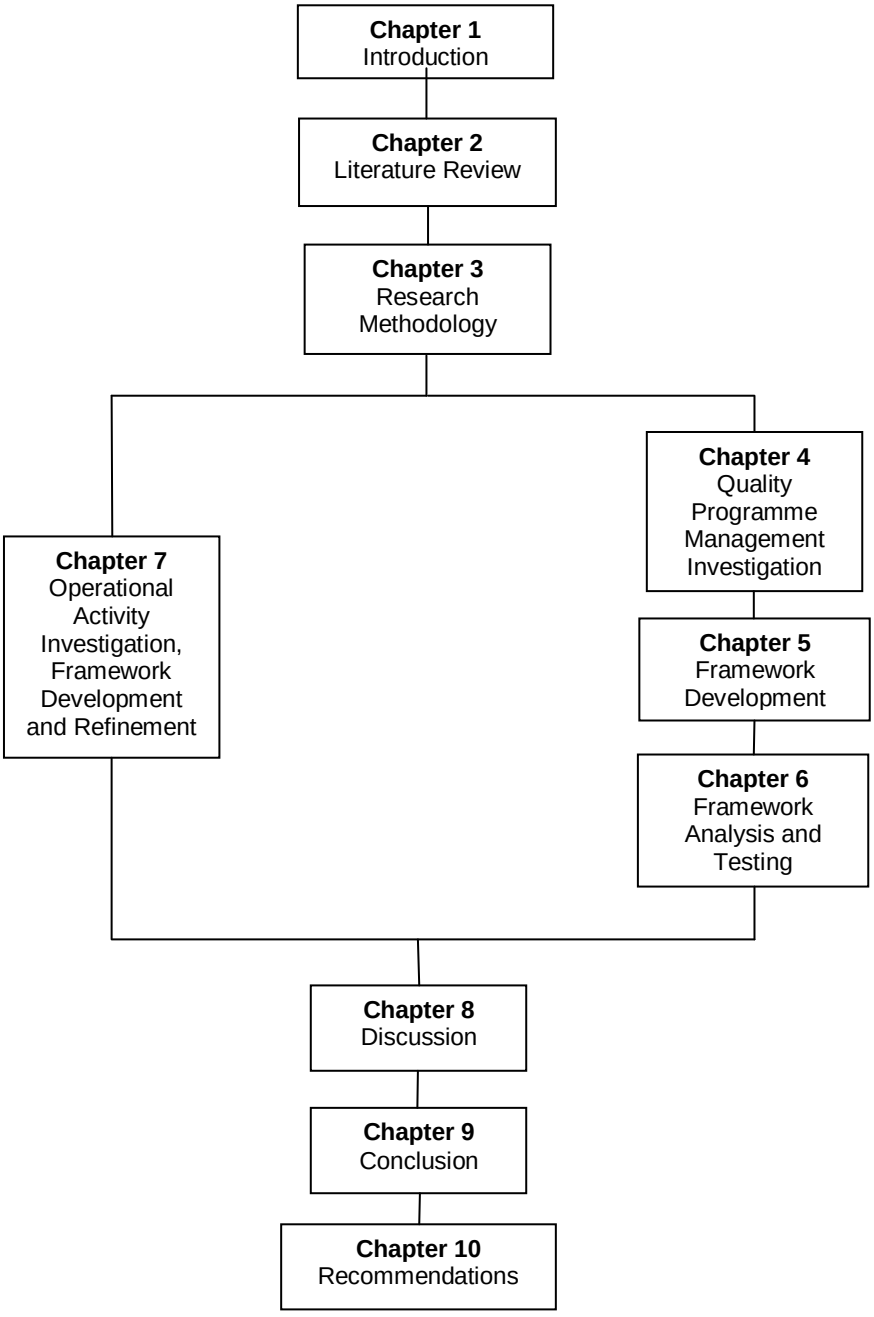


Figure 1.1 Structure of Thesis

2.1 Introduction

The purpose of this chapter is to critically examine research areas in the field of Total Quality Management (TQM) and identify gaps in the research. The literature review will start with a focus on TQM theory in terms of definitions, models and frameworks. It will then examine research in the areas of strategic quality management, quality practices and quality tools and techniques with an emphasis on employee involvement in the area of tool and technique deployment. In the examination of TQM theory a practitioner/application focus will be adopted and in particular will consider how TQM can be operationalised in an organisations quality programme. This chapter will review each area independently then bring the research together, via a critique, to justify the research topic and supporting questions.

2.2 Total Quality Management

This first section of the literature review will examine the definitions and frameworks/models that have contributed to the field of Total Quality Management (TQM).

2.2.1 Definitions

2.2.1.1 Total Quality Management

There are numerous definitions of TQM found in literature and books and according to Boaden (1997) there is little consensus concerning the actual meaning despite her arguing that definitions are important in order to avoid confusion within the fields of TQM and quality management. A sample of TQM definitions has been produced (Figure 2.1 TQM Definitions).

These examples of TQM definitions illustrate the fact that there is not one universally agreed upon statement used to define TQM. McAdam (2000) believes that the TQM terminology is a "holistic discourse which ultimately relates to a set of theoretical concepts and implementation frameworks". This is supported by Larson and Sinha (1995) who surveyed quality professionals for definitions of TQM and found "unique definitions of TQM", with common themes emerging.

It is not the purpose of this research to identify a definition of TQM but to note that the diversity of definitions is likely to have influenced the development of the TQM theory, even to the extent where Boaden (1997) believes it may have hindered the development of theoretical

thinking. Reeves and Bednar (1994) noted that the selection of a pertinent definition would guide and affect the development of conceptual frameworks.

> "TQM is an integrative management philosophy aimed at continuously improving the quality of products and processes to achieve customer satisfaction". (Joseph *et al.* 1999)
>
> "A philosophy of organisation-wide commitment to continuous improvement, with the focus on teamwork, increasing customer satisfaction and lowering costs" (Dean and Bowen 1994)
>
> "TQM is an integrated management philosophy and set of practices that emphasised amongst other things, continuous improvement, meeting customer requirements, reducing rework, long-range thinking, increased employee involvement and teamwork, process redesign, competitive benchmarking, team-based problem solving, constant measurement of results and closer relationship with suppliers" (Ross 1993 cited in Powell 1995)

Figure 2.1 TQM Definitions

2.2.1.2 Quality Management

Heady and Smith (1995) performed a comprehensive review of literature and statistical analysis to determine the difference between TQM and quality management (QM). They concluded that TQM involves the traditional characteristics of QM, but with

- Increased attention to top management
- Decreased attention to most specific business function (employee skill groups)
- Increased attention to many business topics.

This is supported by Boaden (1997) who in examining definitions of TQM finds that it has its origins in quality management. This development is also reflected in the quality practice performance research field. The early work of Saraph *et al.* (1989) refers to quality management (though the authors do not define the phrase) and similarly the work conducted by Flynn *et al.* (1994) uses the phrase quality management (though they did provide a definition (Figure 2.2)).

> "An integrated approach to achieving and sustaining high quality output, focusing on the maintenance and continuous improvement of processes and defect prevention at all levels and in all functions of the organisation, in order to meet or exceed customer requirements". Flynn et al (1994)

Figure 2.2 Quality Management Definition

It can be seen that if this definition is compared to those TQM definitions listed earlier, similarities can be found. It is likely that this is why the above definition, according to Boaden (1997) is not commonly used.

Later research that examined quality practices starts to refer to TQM and indeed even refers to the Saraph research as a TQM model (Joseph *et al.* 1999). Similarly, Ho *et al.* (1999) and Choi and Eboch (1998) use the earlier work as the foundation for determining TQM practices. In the practice performance research (Rao *et al.* 1999, Ahire *et al.* 1996, Samson and Terziovski 1999, Choi and Eboch 1998, Ho *et al.* 1999) it is noticeable that definitions have been overlooked.

2.2.1.3 Quality

The term quality, like TQM, does not have one universal definition. Ho *et al.* (1999) believe that "quality is a multidimensional concept". Many authors have proposed definitions, a selection have been included in Figure 2.3 Quality Definitions.

Customer satisfaction. Juran and Gryna (1993)
Meeting the customer requirements. Oakland (2000)
Conformance to requirements. Crosby (1979)
Continually satisfying customer requirements. Caudell (1997)
The total composite product and service characteristics of marketing, engineering, manufacture and maintenance through which the product and service in use will meet the expectation by the customer. Feigenbaum (1991).

Figure 2.3 Quality Definitions

Garvin (1987) produced a comprehensive set of eight critical dimensions by which to classify and define quality.

1. Performance: the product's primary operating characteristics.
2. Features: product characteristics that supplement the primary operating characteristics.
3. Reliability: the probability of a product failing within a specified time period.
4. Conformance: the extent to which a product's design and operating characteristics meet the required standards (specification).
5. Durability: is the product life a consumer will receive before the product deteriorates.
6. Serviceability: reflects the timeliness, ease and competence to which repairs are fulfilled.
7. Aesthetics: how a product appeals to an individuals five senses.
8. Perceived quality: reputation, image, or other inferences regarding the attributes of product or service quality.

Garvin (1987) suggests that organisations should compete on selected dimensions. Zhang (2001) supports this view and believes these eight dimensions are the basis for different perspectives of quality, which in return affect quality practices.

Reeves and Bednar (1994) also argue that different definitions of quality are appropriate under different circumstances. Their research examined a number of alternative definitions of quality (excellence, value, conformance to specifications, meeting and/or exceeding customers' expectations) and identified strengths and weaknesses associated with each alternative. They conclude that multiple definitions and/or models of quality are required to capture the complexity and richness of the construct and they believe the challenge is to develop models and definitions that are comparable.

2.2.1.4 Definition Conclusions

There is not one definition for quality or TQM and neither can one be promoted more than others can. Generally, researchers have advocated this diversity as a strength of the research field and that practitioners should use the definitions that suit their strategic business needs. In the previous three sections and throughout the literature review it should be noted that different research uses different terminology, to describe essentially the same elements of TQM. Common terms that emerge include: principles, core values, beliefs, practices, techniques, methods, activities, tools. These tend to be particularly used by the research developing TQM concepts, models and frameworks, and other facets of TQM theory. The inconsistency in terminology was noted in research examining organisations' use and interpretation of the phrase TQM (Leonard and McAdam 2002a) and more recently Klefsjo *et al's.* (2008) review of quality management, its development and evolution, recommended that a better theoretical base consisting of common definitions and framework is required. It is not the aim of this research to define quality or TQM, but to note the lack of definitions and the variety of terminology the effect of which will be commented upon later in the chapter.

2.2.2 TQM Prescriptions, Models and Frameworks

This section describes various theoretical TQM models, starting with the quality gurus prescriptions and finishing with the models from literature. The purpose of the section is to present the literature and through consideration of the similarities and differences identify key themes and gaps in the research. These models have been developed by research to describe the components of TQM. They vary in detail from overview tables to detailed models, and in the extent to which they have been validated. The models have been selected for inclusion based upon their diversity.

2.2.2.1 The Quality Gurus

The early development of complex quality management systems was substantially influenced by only a few American and Japanese quality experts (Kruger 2001, Claver *et al.* 2002). These experts, the gurus normally referred to in the literature include Deming, Juran, Feigenbaum, Crosby, Ishikawa, Taguchi, Shingo, Peters and Moller. Comprehensive summaries of the main gurus contributions can be found in Bicheno (1998) and Kruger (2001). The main three gurus are Deming, Crosby and Juran; and Oakland (2000) has compared their messages and deduced that there are a number of differences in the messages. Consequently, Bendall (2000) argues that guruism as the be all and end all of quality ideas is no longer (as) relevant. Whilst Bicheno (1998) believes that the gurus have useful things to say, organisations should select and use what is appropriate. However, the messages of the gurus cannot be ignored, according to Claver *et al.* (2002) the literature on quality management has progressively developed from these initial contributions, identifying differing elements for effective total quality management, even though Deming, Juran nor Crosby used the term TQM (Martinez-Lorente *et al.* 1998).

2.2.2.2 TQM Terminology Axes Model (McAdam 2000)

Using a review of existing literature and practice, five theoretical concepts of TQM were identified and summarised:

- "TQM is strategically linked to the organisational goals.
- Customer understanding and satisfaction is vital within the organisation.
- Employee participation and understanding in continuous improvement at all levels is required within the organisation.
- There is a need for management commitment and consistency of purpose within the organisation.
- The organisation is perceived as a series of processes which incorporate customer supplier relationships" (McAdam 2000).

McAdam (2000) proposed three axes for explaining TQM terminology (Figure 2.4) and argued that they are distinct from each other and should not be confused. The theory-practice axis represents TQM theory and TQM practices including frameworks, tools and techniques. The strategy-operations axis indicates an emphasis on planning and implementation of TQM. The initial start-excellence axis represents the time it takes for organisations to progress through a TQM journey from start to business excellence.

Figure 2.4 TQM Terminology Axes (McAdam 2000)

2.2.2.3. Hellsten and Klefsjo (2000)

These authors view TQM as a management system consisting of values, techniques and tools. They select the term core values as a way to emphasise that these statements should work together to constitute the culture of the organisation, and that they are basic concepts. Techniques are defined as ways to work within the organisation to reach the values. Tools are defined as concrete and well-defined tools, which sometimes have a statistical basis, to support decision making or facilitate the analysis of data. Examples of techniques and associated tools are:

Technique	**Tool**
Quality Function Deployment	House of Quality
Design of Experiments	Factorial design
Quality Award	Award booklet
Process Control	Control charts

Table 2.1 Examples of Techniques and Tools (adapted from Hellsten and Klefsjo 2000)

A model is proposed by Hellsten and Klefsjo (2000) (Figure 2.5) which suggests that the core values, techniques and tools are interdependent and support one another.

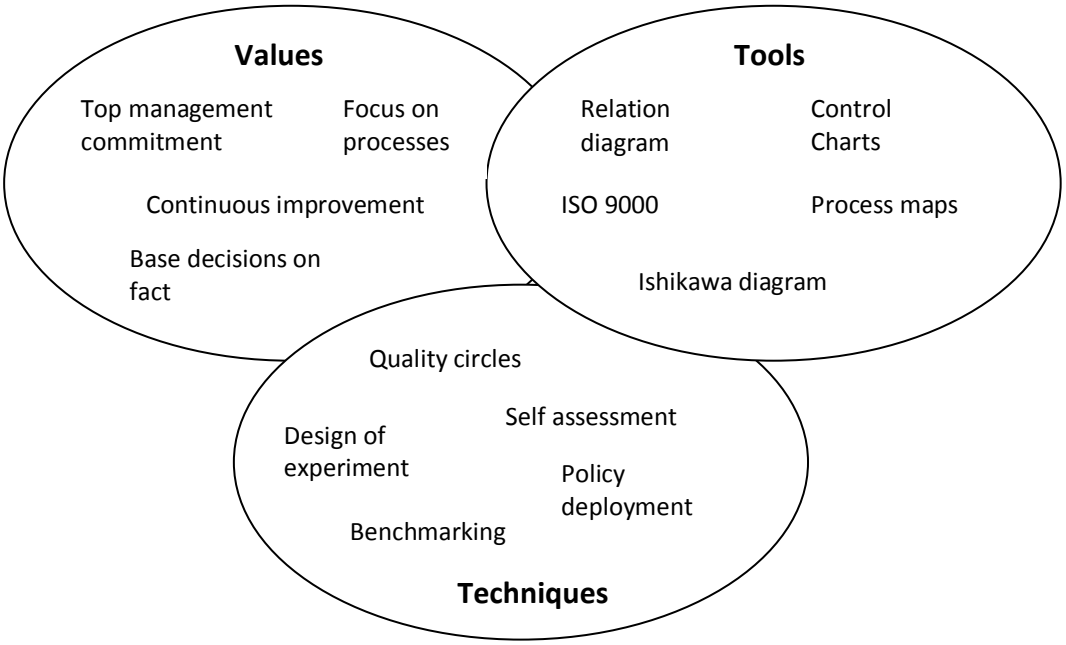


Figure 2.5 Three components of TQM (adapted from Hellsten and Klefsjo 2000)

The authors recommend that organisations should determine which core values they want to promote, which techniques should be selected to support the core value and therefore which tools used as part of the technique. In addition they acknowledge that some techniques will support more than one core value and claim that the advantage of this approach is that over time the core values will change and therefore so will the techniques and tools.

2.2.2.4 TQM Principles, Practices and Techniques (Morrow 1997)

In a study to investigate the relationship between TQM principles and work-related outcomes, Morrow (1997) suggested a model (Figure 2.6) based upon earlier work by Dean and Bowen (1994), where TQM is consists of principles, practices and techniques. Dean and Bowen (1994) believe TQM consists of three principles and explain that "each principle is implemented through a set of practices, which are simply activities such as collecting customer information or analysing processes. The practices are, in turn, supported by a wide array of techniques (i.e. specific step-by-step methods intended to make the practices effective)". However the research by Morrow did not investigate the relationships depicted in the diagram, but suggested further work to establish the utility of the principles-practices-techniques framework. For example she mentioned that TQM principles may only exist as latent constructs underlying TQM practices/techniques or practices and techniques may directly affect outcomes without requiring principles. Note that no definitions were provided apart from the examples listed in the model.

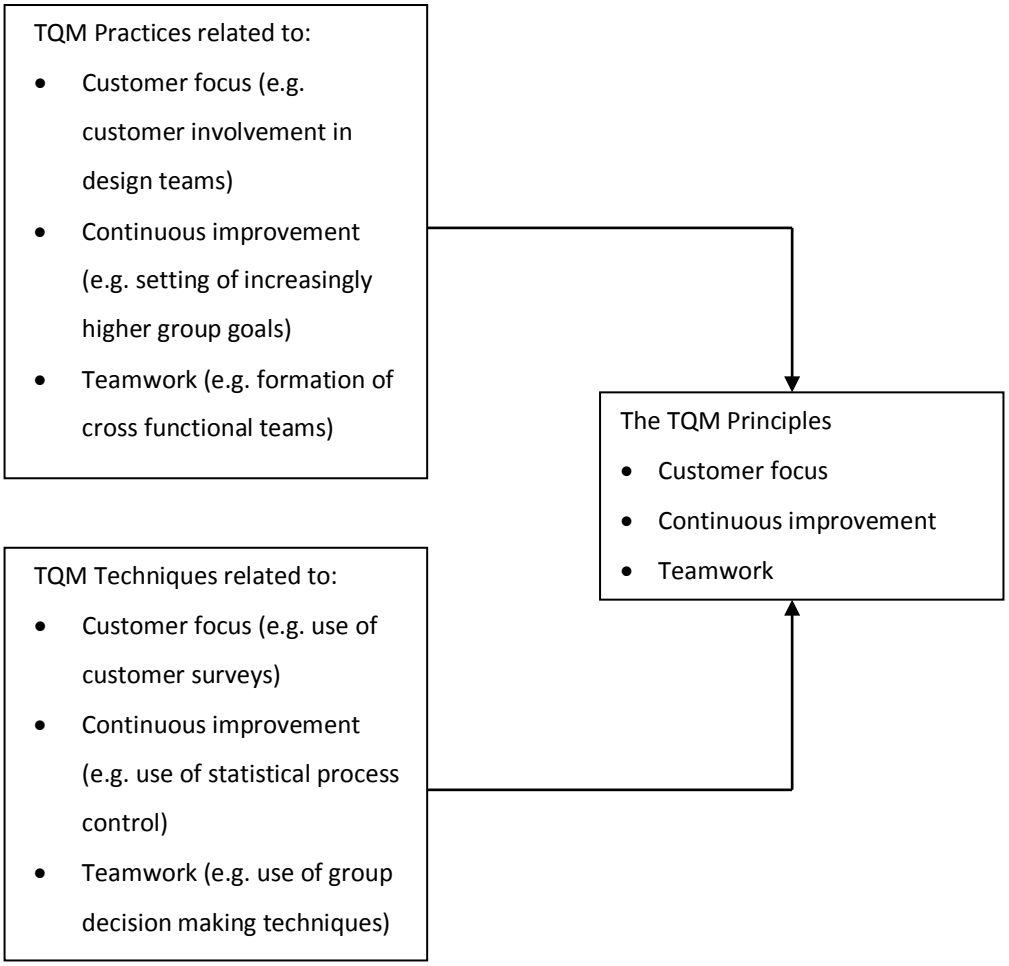


Figure 2.6 TQM Principles, Practices and Techniques (adapted from Morrow 1997)

2.2.2.5 Principles and Practices of TQM (Boaden 1997)

Boaden (1997) in a thorough review to determine what TQM is, identified a distinct difference between principles (beliefs, values, tenets) and quality practices (the actions which demonstrate the principles). Based on the literature review she identified eleven main elements of TQM and then divided them into principles and practices (Table 2.2). She suggests that activities support practices, though does not articulate them as she believes that they will change. In addition she argues that in order to evaluate the success of principles then it is necessary to establish the implementation levels of practices, but does not suggest whether in turn implementation levels of activities should be evaluated.

Table 2.2 Principles and practices of TQM (Boaden 1997) (removed for copyright reasons)

2.2.2.6 Pyramid model of TQM (Kanji and Asher 1996)

Kanji and Asher (1996) propose that TQM comprises four principles and eight core concepts (Table 2.3). (removed for copyright reasons)
Table 2.3 Principles and core concepts of TQM (Kanji and Asher 1996)

Whilst the authors do not define the terminology for principles and concepts, they explain that the principles can be expressed with the help of two core concepts to make the principle workable. In addition, they suggest implementing TQM by practicing TQM methods. The methods are grouped into four categories: management methods (e.g. ISO 9000, quality function deployment, teamwork); analytical methods (e.g. cause and effect, Taguchi methods, FMEA); idea generation (e.g. brainstorming, mind mapping, suggestion schemes); and data collection analysis and displays (e.g. bar charts, checksheets, SPC, histograms). Noticeably these methods were not linked to the concepts or principles but instead the authors suggested management are responsible for ensuring the correct and effective selection and deployment of the methods.

2.2.2.7 TQM Quality Activity Model (Mann and Kehoe 1994)

The TQM Quality Activity Model (Table 2.4) was developed in order to:

1. "Assist organisations in the selection and targeting of quality activities to specific problems and opportunities.
2. Provide organisations with a greater understanding of how quality activities are likely to affect their organisation.
3. Encourage the implementation of quality activities" (Mann and Kehoe 1994).

They define quality activity as a generic term which describes a distinguishable tool or method used for quality improvement, e.g. control charts, ISO 9000, TQM. It is noticeable that they describe TQM as a quality activity consisting of many quality activities.

TQM addresses:	Categories	Quality Activities
Suppliers	Supplier improvement activities	Supplier rating, vendor appraisal, supplier evaluation, source review, suppliers training, supplier certification, quality improvement programme for suppliers
Processes	Process control and improvement activities	Problem solving, statistical process control, failure mode effect analysis, Taguchi methods, quality function deployment
	Internal customer	Informal internal customer systems, formal internal customer system, internal customer contracts

	focus activities	
Policy deployment	Measurement and reporting activities	Strategic measures, sampling, inspection, measurement system, quality costs, departmental/function measures, benchmarking, competitor analysis system, employee measures, diagnostic survey, team/project measures
	Leadership activities	Business plan/goals/strategy, deploy via organisational structure, vision/mission statements, quality council, quality steering team, board steering TQM, within-function quality council teams, champion(s) of quality, cross-functional quality council team
	Quality system activities	Quality policy, quality manual, procedures, internal audits, ISO 9000 or AQAP standards
People	Participation activities	Delegated within-function teams, delegated cross-functional teams, problem/opportunity feedback, briefing groups, voluntary teams
	Recognition activities	Working conditions, salary, reward system, bonus scheme, presentations, award ceremonies, suggestion schemes, profit sharing
	Education and training activities	Quality awareness programmes, quality activity training, newsletters, individual training plan, posters, open days, formal education promotion
Customers	External customer focus activities	Consumer complaint information, market research, customer satisfaction survey, formal feedback system

Table 2.4 TQM Activity Model (Adapted from Mann and Kehoe 1994)

The authors suggest that case study research is required to measure the effects of the quality activities and that mitigating factors to be considered include: implementation method and duration and level of organisations quality maturity.

2.2.2.8 Quality management methods model (Zhang 2000)

A TQM literature review, focusing on quality management methods (QMM) was used by Zhang to categorise 83 QMM according to eleven TQM elements which they can be used to improve. His definition of QMM replicates the definition provided by Mann and Kehoe (1994) for quality activities. His model (Table 2.5) was validated through structured interviews at ten case study companies in the Netherlands.

	Quality management methods
Supplier quality management	Supplier audit, potential supplier evaluation, supplier rating, supplier quality improvement projects, supplier certification, supplier training
Process control and improvement	PDCA cycle, equipment maintenance improvement inspection, self-inspection, process capability, sampling, 7QC tools, SPC, FMEA, foolproofing, 7 new tools, FTA
Product design	Concurrent engineering, reliability engineering, quality function deployment, design of experiments, computer aided design, value engineering, designing for manufacturability

Quality system improvement	Quality manual, quality system procedures, work instruction, ISO 9000 certificate
Leadership	Top management commitment, empowerment, policy deployment, site quality council, cross-functional quality council team, corporate quality council, within-functional quality council team
Vision and plan statement	Vision/mission statement, business plan, quality policy, quality goals, quality planning
Evaluation	Quality audit, employee performance evaluation, employee satisfaction evaluation, team evaluation, department evaluation, business evaluation, strategic evaluation, benchmarking, quality costs, diagnosis survey
Participation	Information communication, establishing quality culture, , suggestion activities, within functional delegated team, cross-functional delegated team, job rotation, improving employee commitment, quality control circle, voluntary team
Recognition and reward	Working conditions improvement, salary promotion, bonus scheme, presentation, award ceremony, moral award
Education and training	Individual training plan, quality awareness education programme, training for job requirements, newsletter, quality management method education, poster, slogan, formal education promotion, quality day
Customer focus	Customer complaint information, customer satisfaction survey, after-sales service, formal feedback system, warranty of quality, market investigation, customer day

Table 2.5 Model of quality management methods (adapted from Zhang 2000)

Zhang (2000) compared his model to that of Mann and Kehoe (1994) and noted the following two major differences: one extra element and 18 additional QMM's. He advocated that the model could be used by organisations to evaluate their applications of QMM's and that research could investigate the effects of QMM's on business performance.

2.2.2.9 Major elements of TQM (Lau and Anderson 1998)

In a theoretical review of TQM literature, Lau and Anderson (1998) argue that TQM consists of three dimensions: philosophical, strategic and measurement. Using their philosophical perspective they extracted the common elements used in defining TQM to produce the framework (Table 2.6).

Lau and Anderson (1998) suggest that it is the responsibility of management to apply the fundamental concepts of TQM that are appropriate for particular business conditions. The authors suggest that the application of TQM is achieved using a strategic quality planning process which is supported by adequate systems for data collection, analysis and continuous improvement.

Total	Quality	Management
Require employee	Customer (internal and	Require commitment from

participation and teamwork	external) driven	top management
Everyone must develop a sense of quality ownership	Emphasis on continuous improvement (kaizen)	Establish purposes and values for the company
Involve every level and function of the company	Technical issues training for skills and knowledge	Leadership is critical
Apply systems thinking	Human issues encourage innovation	Make appropriate change in organisation culture

Table 2.6 Major Elements of TQM (adapted from Lau and Anderson 1998)

2.2.2.10 TQM Model (Oakland 2000)

The Oakland (2000) total quality management model consists of three main features. The core concept is the customer-supplier chain (including internal and external links) where each interface consists of a process. This core is supported by 'soft' TQM elements (culture, communication and commitment) and 'hard' elements (systems, tools and teams). According to Oakland (2000) the model (Figure 2.7) provides a framework against which an organisation's progress towards TQM can be examined although he does not offer any guidance concerning this aspect. The model is supported by "Ten points for Senior Management" which Oakland compiled based upon modified versions of the quality gurus messages.

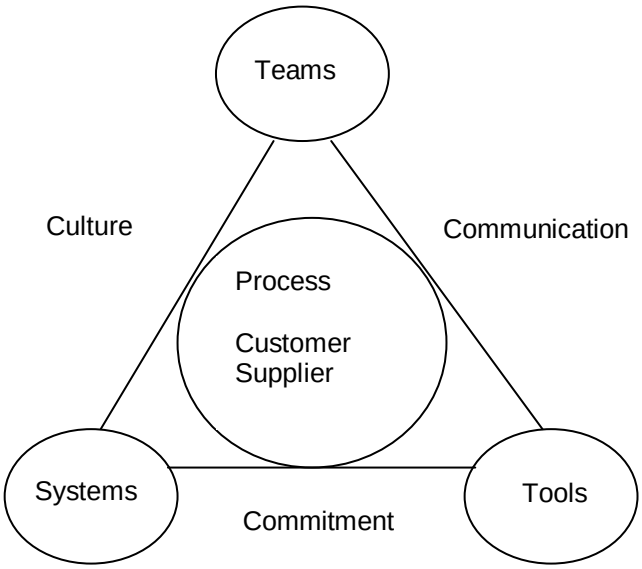


Figure 2.7 Total quality management model – main features (adapted from Oakland 2000)

2.2.2.11 TQM Implementation Frameworks

Whilst TQM implementation guidelines and specific frameworks will not be investigated or detailed as part of this research, it is necessary to note that this field of research has been based upon and has contributed to the TQM theoretical development.

Research (such as Ho and Fung 1994, Davies and Isaac 1998, Yusof and Aspinwall 2001, Thiagaragan *et al.* 2001) propose differing frameworks to enable companies to successfully implement TQM. Often these models are context specific, generated from research in an industrial sector or country. This approach is supported by Mann and Kehoe (1995), who argue that TQM should be tailored to suit an organisation's needs. Yet, one key element of the frameworks is the identification of quality practices to be pursued as part of the implementation process. According to Thiagaragan *et al.* (2001) each author tends to emphasise a selection of quality factors based on their judgement and experience in working with different organisations. For example, if the practices identified by Thiagaragan *et al.* (2001), developed based upon the Malaysian industrial requirements are compared to those generated by Yusof and Aspinwall (2001) created as a result of a focus on UK automotive SME's, a significant difference in the practices advocated can be observed. It is noticeable that in the conclusions by Thiagaragan *et al.* (2001) the authors recommend that organisations complement the guidelines by continually seeking out and studying best implementation practices to understand how others are achieving success in implementing and sustaining TQM.

2.2.2.12 TQM Models Conclusions

There are many models which articulate TQM and a selection of which have been described in order to emphasize the diversity which exists in the literature. These frameworks do not appear to build upon each other but are standalone, separate from each other, each offering an alternative perspective. Though it is apparent there is not a "one size fits all" model which may be due to the different definitions of TQM which were presented earlier. There appears to be some commonalities in terms of themes such as customer focus, strategy, leadership, employees and teamwork. All of the models provide a static prescription of TQM and format of the components within TQM. Research (Hellsten and Klefsjo 2000, Lau and Anderson 1998) alludes to the need for organisations to change what they do to reflect the business needs. None of the models offer a continuous improvement or feedback loop and neither is improved performance directly associated with the models. The models have all been presented from an academic orientation and do not have a practitioner perspective.

The models vary in many respects. Firstly, with regard to terminology, the TQM models refer to principles, values, practices, activities, tools, techniques and quality management methods. Some models are generic and managerially focused whereas others concentrate on the

operational nature of TQM particularly the tools and techniques. Some of the models suggest different relationships between the various elements of TQM whereas others do not consider the linkages. Where relationships or linkages have been implied they have not been investigated, tested or validated. The specificity in the models also differs with overview information or partial/example information offered in some but specific details in others. Also, some models have considered a practitioner and application focus whereas others are theoretically focused.

Finally it would appear that in the broadest sense, the models presented suggest that TQM comprises three main elements:

1. The first element includes Values/Principles/Tenets which seem to suggest the aims of TQM that is, the purpose and rationale or motivation behind the concept for an organisation to select strategically.
2. The second element comprise Concepts or Practices which appear to be a generic "what" should be done, articulating the aims in order to achieve them and make them workable in an organisation.
3. The third element appears to be TQM Methods/tools/techniques, in other words the specific quality activities that are being practiced.

It could be argued that these different elements would be managed or operationalised at different levels within an organisation. The first element can be considered strategic in nature and the third element operational. This split among the definitions in the framework aligns with the concept promoted by Leonard and McAdam (2002a) where they suggest that TQM must be considered at three levels in an organisation: strategic, tactical and operational.

Therefore, given this finding, a top-down approach to the examination of quality literature will be adopted, starting with quality strategy and ending with the operational aspects of quality activities actually deployed.

2.3 Strategic Quality Management

According to Garvin (1987) the beginnings of strategic quality management cannot be dated precisely because no single book or article marks its inception though his eight critical dimensions of quality were offered as a framework for strategic analysis. Since this work, more research has investigated strategic quality management (SQM). Some research (Tummala and Tang 1996, Chin *et al.* 2003) uses the terms SQM and TQM interchangeably as they see them both as part of the evolution in the quality management research arena. In these cases the detail reveals the commonality between the concepts, particularly in terms of the components of TQM and SQM. Whereas others (Calingo 1996, Aravindan *et al.* 1996)

believe that SQM is the alignment of TQM and quality management with an organisations' strategy and the definitions proposed by these researchers emphasize this fundamental difference:

"the organisations TQM system is tightly interwoven with the strategy formulation process" Calingo (1996)

"The process by which quality management activities focus towards the long range direction and progress of quality enhancement strategies by ensuring the careful formulation through strategic quality planning, proper implementation through vital quality strategies, and continuous evaluation through quality improvement and control" Aravindan *et al.* (1996).

Beecroft (1999) suggests that quality should be managed strategically and research (Dale and Lascelles 1997, Dayton 2003, Tena *et al.* 2001 and Dale *et al.* 2001) has identified TQM as an organisational strategy. Beecroft (1999) identified that strategic quality planning should consist of four elements: a quality strategy, goals and objectives, specific quality initiatives and action plans, though he did not discuss relationships between these.

Leonard and McAdam (2002b) also believe that SQM is based on the relationship between the fields of TQM and corporate strategy and using a theoretical review of these two topics conclude that there is a lack of empirical evidence of the application of TQM in a strategic role, particularly in regard to non-financial performance impacts and consequently recommend further research that examines the concept from a practitioner perspective. Research published by Leonard and McAdam has focused on the area of strategy and TQM with an emphasis on the dynamic nature of TQM. Initially Leonard and McAdam (2002c) examined developing strategic quality management and proposed a research agenda to identify the strategic positioning of TQM which led to the adoption of an in-depth longitudinal study and grounded theory research methodology approach to investigate and analyse TQM in organisations. Leonard and McAdam (2002a) argue the need for models which address the dynamic effects of TQM at strategic, tactical and operational levels. This is followed by research (Leonard *et al.* 2002) that describes the Strategic Dynamics of TQM Framework which comprises five linked models: TQM Points of Application Model, TQM Strategic Drivers Model; TQM Profiles Model; TQM Environment Model; and TQM Lifecycle model. These models recognise that TQM is present at strategic, tactical and operational levels. This framework and series of models is then tested by way of multiple case studies in order to analyse TQM in organisations and Leonard and McAdam (2003) conclude that the framework enabled the strategic, tactical and operational roles of TQM to be understood, although acknowledged that there is a need to develop TQM dynamics models in theory and practice. A further case study application is presented (Leonard and McAdam 2004) to demonstrate the framework and models, where conclusions noted a strategic-operational divide where the tactical level of an organisation (middle management) translated the strategy into activities, that TQM is primarily (and even exclusively) used only at an operational level and that TQM is

not sequential or formulaic since each organisation develops its' own approach to TQM including use of tools, techniques and philosophies. Finally, McAdam and Leonard (2005) emphasise that organisations should recognise quality processes (IS0 9000, ISO 14000 and MBNQA) as contributing to strategy as well as operational continuous improvement. They concluded that quality processes were "more effective and directed when clearly linked to strategy processes" and therefore identified the need for research "studies involving theory and praxis, which will study integration of strategy and quality".

To date, the work of Leonard and McAdam has remained as a contribution to the theory development in the field of TQM and there are no additional published cases of organisations following their models in order to manage TQM, either strategically or operationally. Lau and Anderson (1998) argue that harnessing the strategic dimension (of TQM) through strategic quality planning will lead to strategic alignment, employee commitment and goal achievement. Research by Dale and Lascelles, (1997) describes six levels of TQM adoption, and as organisations progress from 1 though to 6, the formulation of strategy for TQM becomes a feature of organisations at level 4 and by level 6 TQM is fully integrated into the strategy such that it is a "way of life". Similarly Bessant and Francis (1999) propose that organisations move through 5 levels of evolution of Continuous Improvement performance and practice, where level 3 "Strategic CI" is the formal deployment of strategic goals and the monitoring and measurement of CI against them and this strategic focus is continued beyond level 3. Other research (Hyland *et al.* 2000) proposes a very similar model to articulate the development stages of CI, where organisations also move through 5 stages and at stage 3 a link between CI and strategic processes is started and then continued through the remaining stages.

Therefore it is necessary to examine methods that have been applied to (quality) strategy planning and management. Quality Awards have been used as models for the strategic implementation of quality initiatives (Stading and Vokurka 2003). The Balanced Scorecard has also been recognised as a strategic management system (Kanji and Sa 2002). Chapman *et al.* (1997) suggest that organisations are interested in QFD and Hoshin Kanri as methods suitable for enabling them to structure their deployment/involvement initiatives.

2.3.1 Quality Awards

Tan (2002) suggested that national quality awards help organisations to improve quality standards by promoting and rewarding excellent organisational performance, and identified three awards in particular which have played a key role. These awards are: the Deming Prize, introduced in 1951 in Japan; the Malcolm Baldridge National Quality Award (MBNQA), introduced in 1987 in USA; and the European Quality Award (EQA), introduced in western

Europe in 1991. Oakland (2000) provides an overview of the MBNQA and EQA. A comprehensive review of 16 national quality awards enabled Tan (2002) to produce a framework covering all the elements, which consisted of ten major criterion and associated descriptions (as shown in Table 2.7).

Empirical research (Curkovic *et al.* 2000a) concluded that the MBNQA framework does capture the concept of TQM. Similarly, Van der Wiele *et al.* (2000) found that these models are based on TQM and they are helpful in defining and describing TQM.

In a comparison and analysis of the MBNQA and EQA criteria, (Tummala and Tang 1996), the conclusions included:

- Both awards are results-oriented awards
- Both give maximum weight to customer satisfaction results suggesting customer focus and satisfaction is the overall goal.

Reames (1998) argues that the strength of the national quality awards criteria for performance excellence lies in its generic format and specifically the MBNQA has been changed in every year since its inception.

Criterion	Description of Criterion
Leadership system	Examines how the company can achieve continuous quality and performance excellence through the driving forces of the senior executives and the involvement of all levels of the organisation
Impact on society	Examines how the company addresses its responsibilities to the public in three major areas: social responsibility; community involvement and environmental conservation
Information and analysis	Examines the selection, analysis, and utilisation of information and data in the organisation itself and within and outside the organisation's industry and markets
Strategy and policy planning	Examines how the company develops, communicates, implements and improves its strategy and policy to achieve company performance excellence and strong competitive position
Resources	Examines the management of various resources in the organisation; namely financial, materials, technology, intellectual property, and assets
Customer management and satisfaction	Examines the ability of the company in satisfying the needs and expectations of the customers through gain in customer and market knowledge and enhancement in customer relationship
People management	Examines how the company plans and develops its human resources to achieve the maximum potential of its workforce
Process management	Examines the design, management, evaluation and improvement of the various key processes to achieve product and service excellence
Performance and management of suppliers/partners	Examines how the company selects and manages its suppliers/partners to ensure that they attain the expected quality requirements
Business results	Examines the company's performance in two areas: financial and market results, and operational and productivity results

Table 2.7 Summary of the comparative framework (for National Quality Awards). Adapted from Tan (2002)

Stadding and Vokurka (2003) review and conduct a comparative analyse of a selection of quality awards (MBNQA, EQA, Deming Prize, Canadian Quality Award and Australian Quality Award) with a particular focus on the link between award criteria content and process in order to evaluate TQM as a strategic initiative. They found that the awards are evolving to include strategic content and that the quality practices and principles within the awards can be a model for implementing TQM strategy.

Research advocates the use of the award criteria for the purpose of self-assessment, that is, an organisation measuring itself against the criterion and finding 'gaps' (Oakland 2000, Jackson 1999, Reames 1998, Ritchie and Dale 2000, Siow *et al.* 2001). According to Oakland (2000) self-assessment promotes business excellence by … a regular and systematic review of processes and results. It highlights strengths and improvement opportunities and drives continuous improvement. Zairi (1999) suggests that the MBNQA and EQA criteria can be used to assess the effectiveness of policy and strategy.

However, Leonard *et al.* (2002) suggest that these models lack both a strategic formulation influence and dynamic influence for TQM in organisations and that TQM is more dynamic and non-sequential than suggested by such frameworks. Specifically suggested weaknesses associated with business excellence models (e.g. national quality awards such as EQA and MBNQA) is that they are a snapshot and do not cover the dynamic evolving element of TQM. Recent research has found a move from the EFQM model towards a dynamic system for business excellence (Mavroidis *et al.* 2007). In addition, the national quality award models do not address the different levels of application of TQM through an organisation's activities – strategic, tactical (strategy implementation) and operational.

2.3.2 Balanced Scorecard (BSC)

Kaplan and Norton (1992) introduced the Balanced Scorecard (BSC) as a performance measurement framework, and since then it has developed into the cornerstone of a strategic management system (Kaplan and Norton 1996) and more recently evolved into an organisation change framework (Kaplan and Norton 2000). It is now viewed as a new approach for strategy development and deployment that has entered the management scene during the last decade (Dabhilkar and Bengtsson 2003). Ahn (2005) believes the BSC concept can be considered as an established management tool. Marr and Schiuma (2003) found that the BSC was the dominating concept in the research area of business performance measurement.

According to Dabhilkar and Bengtsson (2003) the BSC is a multi dimensional approach to performance measurement and management control that is linked specifically to

organisational strategy. One of the major strengths is the emphasis it places on linking performance measures and action plans at all levels with business unit strategy. Johanson *et al.* (2006) suggest that the BSC assists top management in gaining a better understanding of what internal and external activities are to be regarded as important in the long-as well as the short-term, expressed in both financial and non-financial terms. In addition, research (Atkinson 2006, Johanson *et al.* 2006) suggest that employees at all levels in an organisation can be involved in the BSC process and see how their activities contribute to strategic priorities and business unit objectives.

The BSC documents goals and measures using four perspectives: Financial, Customer, Internal Business and Innovation and Learning. In doing so, it "forces managers to focus on the handful of measures that are most critical" (Kaplan and Norton 1992). Also, it encourages linkages to be identified between the four sets of measures which suggest convincing cause and effect relationships that have led to widespread circulation of the BSC (Johanson *et al.* 2006). In contrast, Atkinson (2006) believes the causal relationship is overtly recognised between the four and similarly, Kanji and Sa (2002) suggests that the causality links between the four perspectives are problematic and ambiguous.

However, a number of criticisms have been cited in research on the BSC (Atkinson 2006, Kanji and Sa 2002). In particular, Atkinson (2006) summarises a number of criticisms identified in the research to date which includes: not effectively addressing employee and supplier contributions and/or the role of the community, the risk of developing independent and uncoordinated lists of measures, little research into implementation issues and effectiveness, and questions raised about the efficacy and validity of the framework. Ahn (2005) investigated BSC applications and found that BSCs are published that show no thoroughly conclusive connection with the respective company missions. Therefore he proposed an alternative approach based on the idea that BSC perspectives should be directly derived from the company's mission. Johanson *et al.* (2006) examine the critical issues in the implementation and use of the balanced scorecard, motivated by an overall high rate of implementation failure in various practical settings. The authors note that the main difficulty appeared to be selecting the most adequate measures. Also, too strong a focus on measures instead of promoting understanding and learning may alienate the individual employee who is intended to be mobilised. Further research has been recommended to assess the effectiveness of the balanced scorecard in mediating the understanding of the strategic initiative and whether people actually understand their role and its link to organisational strategic priorities (Atkinson 2006).

It would appear that the purpose of the BSC is to connect strategy to operations and involve all employees. However, the BSC is strategically focussed in the broadest sense, since it looks at the whole organisation rather than a single perspective such as the quality strategy.

In addition, as noted earlier it has been suggested that further research is required to establish whether it does actually involve all employees and enable them to see their contribution. Also, the BSC is strongly measure focused since its original conception was as a performance measurement and management tool. Finally, although cause-effect linkages are key to the BSC, the nature of the trade offs appears to be informal or unstructured.

2.3.3 Hoshin Kanri (Policy Deployment)

Hoshin Kanri was developed in Japan in the early 1960s in parallel with Quality Function Deployment (QFD) (Hunt and Xavier 2003) in order to communicate a company's policy, goals and objectives throughout its hierarchy (Lee and Dale 1998).

Research by Lee and Dale (1998) observed that the terms Hoshin Kanri and Policy Deployment were used interchangeably on their examination of existing literature on these topics. They also noted a general "scarcity of material on the topic" and thought that "little academic effort appears to have been expended on the use of policy deployment to achieve quality improvement and business results." However the authors provide a detailed review of existing literature and a summary of the policy deployment process.

Whilst Policy Deployment mainly focuses on the business planning process in order to improve organisation performance, it also encourages employees though especially management, to become involved in the objectives setting process through a method called catchball (Lee and Dale 1998, Walker 2002, Witcher 2002, Killen *et al.* 2005). This process encourages an organisation to concentrate on the vital few objectives (Lee and Dale 1998, Walker 2002, Witcher 2002).

Hunt and Xavier (2003) reviewed a number of research articles and applications of policy deployment and believe "it could be argued that Hoshin Kanri is not a strategic planning tool in itself but more of an execution tool for deploying an existing strategic plan throughout the organisation." Similarly Killen *et al.* (2005) suggest that Policy Deployment is commonly used to manage strategic change and monitor implementation. Hunt and Xavier (2003) conclude that "while Hoshin Kanri approaches are very good and well accepted for deployment, something more is required actually to develop the vision and mission that will be deployed." According to Lee and Dale (1998) "the concept still appears to remain undervalued, underutilised, and under researched."

Policy Deployment has been developed to link strategy to activities throughout an organisation, whilst ensuring that the company focuses on a few key priorities although it appears not to focus particularly on performance measures. The fact that not many

organisations are using policy deployment and that it appears to be under researched suggests that it is not particularly popular or well known. Witcher (2002) identified issues that emerged from its implementation in UK industries. Consequently, it appears that policy deployment has not been adjusted by other organisations or researchers nor readily implemented.

2.3.4 Quality Function Deployment (QFD)

QFD originated in Japan and since 1966 has been practiced by leading companies around the world (Akao and Mazur 2003). The core principle of this concept is a systematic transformation of customer requirements and expectations into measurable product and process parameters (Herrmann *et al.* 2004). This enables product development to focus upon customers needs and ensure that they "are properly deployed throughout the design, build and delivery of a new product" (Akao and Mazur 2003). Research (Akao and Mazur 2003) provides a factual synopsis of QFD, its' history, developments and applications. These authors noted that the blending of QFD with strategic management and strategy formulation, including Hoshin Kanri has been spearheaded outside Japan by Robert Hunt (Hunt (2000), cited in Akao and Mazur 2003). There are now many documented applications of strategic QFD that give valuable insight into the potential application of many of its principles to strategy (Hunt and Xavier 2003). In recent years a number of researchers (Walden 2003, Crowe and Cheng 1996, Killen *et al.* 2005, Walker 2002) have specifically adopted QFD for this purpose.

Research by Crowe and Cheng (1996) used QFD including four house of quality matrices to support a framework and step-by-step instructions, in order to deploy manufacturing strategy into detailed action plans at the shop-floor level. Step six in the process is called feedback and revision stage which requires progress reports to be sent from the bottom to the top in order "to see if the performance is as good as expected" (Crowe and Cheng 1996). However, the framework does not include performance measures and therefore the impact/success of the tasks cannot be compared against each other. In fact Crowe and Cheng (1996) suggest further research is required to answer "how can the effect of a particular manufacturing initiative be assessed?"

Walden (2003) used QFD to facilitate a detailed, quantitative analysis of how well the various strategic thrusts and initiatives at Boeing A&T address the individual items within the MBNQA criteria. The research was used to understand how well the companies best practices and initiatives address the award criteria and subsequently "analyse relationships for synergy/trade-offs, identify gaps and redundancies, and benchmark progress against other organisations through competitive comparisons".

Research by Killen *et al.* (2005) used QFD for strategic planning. The authors used four case studies to demonstrate that "strategic QFD systematically translates vision into action in a series of logical steps: researching customer outcomes, analysing segments, targeting opportunities and creating innovative strategies that are stable in fast changing environments". In this work the QFD process generated strategies and therefore the research is strategically focused and does not consider deployment into detailed activities or performance measurement.

According to Walker (2002) quality function deployment (QFD) is a customer driven, forward-thinking and action oriented market positioning and strategic planning technique, used for product development, business development, organisational improvement and a range of other applications. The author uses QFD at the front end of his framework because it enabled the main customer objectives to be emphasized and prioritised.

Research (Crowe and Cheng, 1996) has shown that QFD holds great promise as a strategic planning tool. QFD helps to identify what is important by providing a logical system to replace emotion based decision-making (Hunt and Xavier 2003, Guinta and Prayzler 1993). In simple terms Clargo (2004) states QFD helps organisations think through what they are going to do, and how they are going to do it. Whilst Walker (2002) argues that QFD is flexible because an organisation can vary the matrices to suit their requirements and that unlike the balanced scorecard, it provides a logical and systematic method to translate corporate goals into action plans.

It is apparent that QFD has been adapted and used by researchers for strategic planning and identifying action plans. The QFD matrices facilitate objective evaluation and previous researchers have been able to make small/minor changes to them to accommodate their own research.

2.3.5 Comparison of Techniques to facilitate SQM

The four methods presented as suitable for strategic quality planning offer a number of options. The quality awards are a relatively prescriptive approach which describes criteria to be adopted in order to achieve SQM. The identification of a set of practices and principles and prior determination of performance measures offers limited flexibility to organisations wishing to manage their own strategic approach to TQM, quality activities and improved performance and make their own connections. The remaining three models, Balanced Scorecard (BSC), Hoshin Kanri (HK) and Quality Function Deployment (QFD) offer greater scope for organisations to manage their quality programmes and have been compared (Table 2.8). Depending on the organisation, its purpose and experiences to date it would seem that any of these could be used to facilitate implementation of SQM.

Factor	BSC	HK	QFD
Application Variety	• Business performance measurement and management • Links business strategy to performance measures • Four predetermined perspectives limits variety • Model applies to whole organisation	• Limited to deploying policy through organisation • Execution of strategic planning	• Originally product development tool • Many varied applications from software development, service design, supply chain re-organisation • Strategic QFD recently developed
Application Quantity	• High rate of implementation failure though many adopters	• Limited research available suggests lack of adopters and users	• Many applications, existed since 1960's with rapid expansion and adoption during 1980's
Operation-alised by	• Management owned and managed • All employees could be involved but further research required	• Management and employees throughout organisation	• Management and employees
Ease of Use	• Implementation/effectiveness issues not fully researched suggests ease of use not investigated	• Not known due to lack of use in UK, appears straightforward	• Many adopters across range of applications suggest it is easy to use
Flexibility/ Adaptability	• Few researchers have adapted model	• Limited research, evidence not available	• Very flexible, many different/adapted charts published • Modifying charts "encouraged"
Deployment Connections/ Linkages	• Promotes connections and suggests cause and effect links but published work found no conclusive evidence • Trade-offs informal and unstructured	• Based on linkages and cascading strategy down through organisation	• Promotes connections as designed to deploy "voice of customer" through charts • Communication tool • Formalised, structured approach

Table 2.8 Comparison of Balanced Scorecard (BSC), Hoshin Kanri (HK) and Quality Function Deployment (QFD)

2.3.6 SQM Conclusion

Chang *et al.* (2003) recommend that any quality programme implemented to achieve a competitive edge requires careful planning and a strategic approach to TQM is required for organisations adopting a more sophisticated approach. Therefore although TQM is a means of achieving strategic level targets (Leonard and McAdam 2002c), SQM offers organisations an approach to align TQM with strategy. Research has advocated the use of the BSC, HK and QFD as methods to strategically manage TQM and its implementation. However, Leonard and McAdam (2002c) observed that organisations were failing to use TQM as a strategic driver and advocated the need for "more work in this area, from models to tools and techniques."

2.4 Quality Practices

2.4.1 Introduction to Quality Practices

It was suggested that quality concepts/practices were the tactical level in a quality management programme and therefore will be considered next.

Research by Saraph *et al.* (1989) was the first to examine quality management in order to establish a set of critical factors which articulate quality management. This work identified eight critical factors of managerial planning and action that must be practised to achieve effective quality management (Saraph *et al.* 1989). These factors were supported by a set of operational measures (items) which the authors suggested could be used by researchers to understand quality management practice and relate the factors of quality management to quality performance. It was also suggested that practitioners could use the instrument to determine priorities for action and facilitate quality management implementation. The work was developed based upon a literature review and tested and refined through a survey and statistical analysis. This work triggered a significant interest in this field and over the next decade a number of similar survey-based studies were conducted which looked at quality management/total quality management in order to identify a set of constructs which represent the theory.

Therefore this body of research will be examined further in order to provide:

1. a comparison of critical factors/quality practices.
2. an examination of the relationships between quality practices.
3. information about the link between quality practices and performance.

During the period 1989 – 2000 there was significant interest in quality practices amongst academic researchers, in particular focusing on trying to determine a set of practices which comprise TQM. (It should be noted that in this body of research quality practices were examined in a generic sense and the specific details of quality programmes and activities that were being deployed by organisations were not considered.) This period contributed to theory building in this particular topic whereas it was found that research post 2000 has concentrated on synthesising these original investigations. For example, in the period since 2000 researchers (Motwani 2001, Sila and Ebrahimpour 2002, Sila and Ebrahimpour 2005, Karruppusami and Ganhinathan 2006) have synthesised the original work conducted between 1989 and 2000. In addition, further studies (Claver and Tari 2006, Baidoun 2006) have looked at developing quality practice models for context specific situations based on the work presented between 1989 and 2000. Research into TQM implementation frameworks (Sharma and Kodali 2008) also used the quality practice research from the 1989 – 2000 timeframe. Therefore this research will examine, compare and analyse the original theory building research. The research was selected for inclusion in this review based upon: its' originality concerning the developing and examining sets of quality practices; the relationships between practices and performance measures; the research has been conducted using empirical methods; the data includes manufacturing organisations; and it has presented detail information. Replicating studies have been reviewed, and where appropriate will be referenced, however, if they have not made an original contribution to the field they are not included in the comparisons. Therefore research by Motwani et al. (1994), Quazi et al. (1998) and Kaynak (2003) which replicates the Saraph et al (1989) work has been omitted.

2.4.2 Comparison of Quality Practices

In total, fifteen sources of research have been identified, reviewed and summarised (appendix A1). Firstly the research has been compared to give a general indication about the nature of the research and provide overview information concerning the quality practices, detailing their source, name, quantity, supporting items names and quantities (Table 2.9). Examination shows that the origin for the research to establish the practices varies, which could account for the differences across the research. For example, Saraph *et al.* (1989) developed the practices based on the work of the quality gurus, whereas Choi and Eboch (1998) used the quality awards for guidance. Also the names given to the framework/model categories varies, including names such as Critical Factors (Saraph *et al.* 1989), Quality Improvement Activities (Ahire *et al.* 1996) and Practices (Choi and Eboch 1998). In order to maintain consistency the name "quality practice" will be used as this alludes to its' purpose. In addition Abdul-Aziz *et al.* (2000) define quality practices as using quality management techniques and similarly Adam *et al.* (1997) suggest a set of quality

practices comprise TQM. The quantity of the quality practices, identified by the research varies from three to twelve. Research (Ahire *et al.* 1996, Rao *et al.* 1999) suggests that these quality practices cannot be measured directly as they are latent variables. In effect the quality practices comprise items which describe how they manifest themselves. There are also differences in the terminology used in the framework/model details to articulate each quality practice, with names such as activities (Flynn *et al.* 1994), items (Powell 1995) and operating system elements (Joseph *et al.* 1999). There is a significant variation in the quantity comprising the set of quality practices from ten (Curkovic *et al.* 2000b) to one hundred and six (Joseph *et al.* 1999). For the purpose of this research the supporting details are called items.

The next phase of this investigation is to compare the actual quality practices proposed. In order to examine the quality practices identified by the empirical research, a judgmental process (similar to that adopted by Motwani 2001) was used to group similar quality practices together. The purpose of this was to establish emerging key themes in total quality management practices, and determine similarities and conflicts amongst the research so far. The grouping process was based upon the name given to the quality practices, which varied amongst the research, so therefore the results (Table 2.10) provide an overview, which used the original Saraph *et al.* (1989) model names as the predominant starting point (because it is the pioneer study (Rao *et al.* 1999). It can been seen that the five most frequently identified quality practices were Employees, Management Leadership and Quality Policy, Quality Data and Reporting, Customers and Supplier Quality Management, all of which appeared in at least ten of the fourteen frameworks/models. However, some quality practices only appeared in one model, for example, inventory reduction, zero defects mentality and JIT principles.

Research	Data Source	Practice Name	Total No. of Practices	Detail Item Name	Total No of Items
Saraph *et al.* 89	Theory/Gurus	Critical Factors	8	Items	66
Flynn *et al.* 94	Literature review and plant visits	Dimensions of quality management /practices	7	Activities	43
Flynn *et al.* 95	Literature review	Scale Title	12	Items	41
Adam *et al.* 97	Adam 94	Quality Improvement Factors	9	Items	46
Powell 95	Literature review	TQM Factors	12	Items	47
Madu *et al.* 96	Literature review	Dimensions	3	Items	22
Ahire *et al.* 96	Literature: prescriptive, practitioner, conceptual, empirical	Quality improvement activities	10	Items	55
Choi and Eboch 98	MBQA and literature	Practices	4	Activities	21
Joseph *et al.* 99	Saraph *et al.* 89, literature review	Critical Factors	10	Operating system elements	106
Anderson and Sohal 99	Australian quality awards framework	Criteria	6	Practices	43
Dow *et al.* 99	Various awards criteria	Manufacturing management practice constructs	9	Quality practice instruments	44
Ho *et al.* 99	As Saraph, split into core or supportive categories	Critical Factors	8	No name	66
Rao *et al.* 99	Literature and quality awards (MBQA)	Constructs	11	No name	53
Samson and Terziovski 99	MBQA and Adam 94	Elements	6	Items	32
Curkovic *et al.* 2000	Literature review	Programs	10	Definition of program	10

Table 2.9 Overview of quality practice research

Quality Practices	Saraph *et al.*	Flynn *et al.*	Flynn *et al.*	Adam *et al.*	Powell	Madu *et al.*	Ahire *et al.*	Choi and Eboch	Joseph *et al.*	Anderson and Sohal	Dow *et al.*	Ho *et al.*	Rao *et al.*	Samsonand Tervioski	Curkovic *et al.*	Number
Year	89	94	95	97	95	96	96	98	99	99	99	99	99	99	00	
Management leadership and quality policy	X	X		X	X		X	X	XX	X	X	X	X	X	X	13
Role of quality dept	X								X			X				3
Training	X			X	X		X		X		X	X	X		X	9
Product / service design	X	X	X	X			X		X	X		X	X			9
Supplier quality management	X	X	X		X		X		X		X	X	X		X	10
Process management	X	X	X					X	X			X		X		7
Quality data and reporting	X	X	X		X		X	X	X	X		X	XX	X	X	12
Employee relations/involvement/empowerment/ teams	X	X	X	X	X	X	XX	X	X	X	X	X	X	X	XX	15
Customer Involvement/ focus/ satisfaction		X	X	X	X	X	X			X	X		X	X	X	11
Employee satisfaction				X												1
Compensation				X												1
Employee selection and development				X												1
Inventory reduction				X												1
Employee service quality						X										1
Adoption/communication of TQM / shared vision					X					X	X		X	X		5
Benchmarking					X		X				X		X		X	5
Open Organisation/ quality citizenship					X								X			2
Process Improvement/ SPC					X		X								X	3
Flexible Manufacturing					X											1
Technology utilisation									X							1
Zero defects mentality					X											1
Use of advanced manufacturing systems											X					1
Use of JIT principles											X					1
Continuous improvement															X	1

KEY: X One practice in this category: XX Two practices in this category

Table 2.10 Summary of the Quality Practices

It should be noted that there was variation in the practice names used by each author and this was common across all papers and all quality practices. For example, a comparison of the quality practice "Employees" which appears in all papers shows the difference in the precise phrases used to describe this quality practice by the various researchers (Table 2.11). The fourteen papers, used eleven different phrases, whilst Ahire *et al.* (1996) and Curkovic *et al.* (2000b) each proposed two elements within the employee related quality practices: involvement and empowerment (Ahire *et al.* 1996); and empowerment and cross functional teams (Curkovic *et al.* 2000b). Adam *et al.* (1997) identified three employee related practices: employee involvement, employee satisfaction and employee selection and development. Therefore, it could be argued that this generic name grouping oversimplifies the differences between the research.

Saraph *et al.* 1989	Employee relations
Flynn *et al.* 1994	Workforce management
Flynn *et al.* 1995	Workforce management
Adam *et al.* 1997	Employee involvement
Powell 1995	Employee empowerment
Madu *et al.* 1996	Employee satisfaction
Ahire *et al.* 1996	Employee involvement; Employee empowerment
Choi and Eboch 1998	Human resources
Joseph *et al.* 1999	Human resource management
Anderson and Sohal 1999	People
Dow *et al.* 1999	Use of teams
Ho *et al.* 1999	Employee relations
Rao *et al.* 1999	Employee involvement
Samson and Terziovski 1999	People management
Curkovic *et al.* 2000	Employee empowerment; Cross functional teams

Table 2.11 Comparison of Quality Practice Names: Employees

If the item details which support the quality practices are identified, the differences become even more apparent. For example, Powell (1995), Ahire *et al.* (1996) and Curkovic *et al.* (2000b) all identify Employee Empowerment as a key practice. Yet each researcher examines different attributes within the field of employee empowerment. A comparison of the items comprising this practice name shows (Table 2.12) the supporting details/definitions of this practice. The specific item details vary from a broad prescription offered by Curkovic *et al.* (2000b), to involvement and autonomy issues identified by Powell (1995), to specific problem solving responsibilities proposed by Ahire *et al.* (1996).

POWELL 1995	**AHIRE *et al.* 1996**	**CURKOVIC *et al.* 2000**
Increased employee involvement in design and planning	Workers authorised to inspect their own work	Allowing employees to decide on their own how to go about doing their work and ensuring action is taken on employee input
A more active employee suggestion scheme	Workers encouraged to find and fix problems	
Increased employee autonomy in decision making	Workers given resources to fix problems	
Increased employee interaction with customers and suppliers	Technical assistance given to workers for solving problems	
	Supporting infrastructure for problem solving	

Table 2.12 Comparison of item details for Quality Practice Employee Empowerment

The variety which has been demonstrated within the quality practice names and supporting items is not unique to the 'employee' quality practices, but in fact is reflected in the other practices too. Therefore this demonstrates the complexities involved in trying to articulate specific quality practices and ultimately TQM. These mixed messages about the quality practices and their content means that practitioners trying to implement quality programmes do not have clear guidance to follow even though some authors (Saraph *et al.* 1989, Ahire *et al.* 1996, Joseph *et al.* 1999, Ho *et al.* 1999) suggest the TQM frameworks (surveys) can be used by practitioners to measure the extent of TQM implementation and hence focus quality efforts accordingly. It can be concluded that literature advocates the adoption of different quality practices in order to implement TQM in different organisational settings, therefore affecting the actual specific quality practices performed.

2.4.2.1 Quality Practice Investigations Research Methods

Given the difference in the quality practice research outcomes the research methodologies used has been compared (Table 2.13) to provide a general overview. All of the work was survey based, statistically validated and each of the authors claimed that their work was valid and reliable. Most research (ten studies) was based on or included responses from the US and most focused on manufacturing industry and large organisations. All the papers used surveys which assessed managers' perceptions on quality practices and obtained either subjective or objective data on performance. Only Flynn *et al.'s* (1994) work surveyed multiple respondents from different levels in the company; although some (Saraph *et al.* 1989, Joseph *et al.* 1999, Ho *et al.* 1999) averaged responses from two managers.

Research	Industry Sector/ country	Respondent Profile	Responses
SARAPH *ET AL.*1989	Manufacturing & service, small, medium and large firms, US	General manager and top quality manager	20 companies, with 89 divisions
FLYNN *ET AL.*1994	Manufacturing, 3 sectors only, US	Direct labourers, Plant Manager, Quality Manager, Production &Inventory Manager, Supervisors, Process Engineer, HR manager	
FLYNN *ET AL.*1995	Manufacturing, 3 sectors only, US		
ADAM *ET AL.*1997	Manufacturing & Service, North America, Asia, Europe	Management	
POWELL 1995	Manufacturing and service, US, 50+ employees	CEO's or Senior quality executive	36 surveys, + 23 surveys through on-site interviews
MADU *ET AL.*1996	Manufacturing and service, Mid Atlantic US	Middle managers	165 survey responses
AHIRE *ET AL.*1996	Automotive component manufacturing,, US, 100+ employees	Plant Managers	
CHOI AND EBOCH 1998	Transportation and electronics parts manufacturers, incl. metal stamping and coating, US Ohio	Plant Managers	339 surveys
JOSEPH *ET AL.*1999	Manufacturing, India	CEO/General manager and Chief Quality Manager	25 Business units, 50 responses (2 per firm)
ANDERSON AND SOHAL 1999	Australia SME's		62
DOW *ET AL.*1999	Australia & New Zealand Manufacturing, 20+ employees	Management	698 useable surveys
HO *ET AL.*1999	Hong Kong electronics manufacturers, with TQM	Quality Manager and Production or Marketing manager	25 firms (50 responses)
RAO *ET AL.*1999	Manufacturing and Service, US, India, China, Mexico and Taiwan	CEO's or Quality manager	780
SAMSON AND TERZIOVSKI 1999	Australia & New Zealand Manufacturing, 20+ employees	Management	1024
CURKOVIC *ET AL.* 2000B	150 largest 1st tier US automotive suppliers	CEO's	57

Table 2.13 Overview of Research

2.4.3 Relationship between Quality Practices

A number of the authors who examined TQM in order to establish which quality practices it comprises also considered the existence of relationships between the practices, particularly in terms of how the practices linked with each other and then ultimately with improved performance. Several key themes have emerged in the research:

1. Developing a model consisting of TQM practices, classifying them into factors and investigating the relationships of the factors (as one TQM construct) to performance (business, operational and quality). (Saraph *et al.* 1989, Flynn *et al.* 1994, Flynn *et al.* 1995 and Joseph *et al.* 1999).
2. Developing a relationship model, focusing on all the TQM factors and how they each relate to business, operational and/or quality performance. (Adam *et al.* 1997, Ahire *et al.* 1996, Forker *et al.* 1996, Samson and Terziovski 1999).
3. Developing a relationship model by grouping the TQM practices and then examining the effect of these separate groups on performance (Forza and Filippini 1997, Choi and Eboch 1998). For example, Ho *et al.* (1999) created two categories quality management infrastructure and core quality management practices in which to group the quality practices and analyse their affect on performance. Further research (Ho *et al.* 2001) called the two groups supportive factors and core factors and examined the relationships further and suggested a mediating effect in the relationship.
4. Investigating a limited selection of factors and relating them to one or more measures of performance (Madu *et al.* 1996, Morrow 1997).

The various research approaches, offering different results, has resulted in no uniform view or conclusions concerning the relationships between practices. Ho *et al.* (2001) commented that the mixed findings add to the confusion surrounding the practice performance relationship. The fact that different studies use varying levels of specificity, as well as different contents, makes it difficult to compare findings (Bolden *et al.* 1997).

2.4.4 Quality Practices and Performance

The link between quality improvement practices and business performance has been well documented (Forker *et al.* 1996, Hendricks and Singhal 1997, Powell 1995, Madu *et al.* 1996). Similarly, the link between quality improvement practices and quality performance has been investigated (Adam 1994, Adam *et al.* 1997, Flynn *et al.* 1994, Flynn *et al*. 1995, Ahire *et al.* 1996, Handfield *et al.* 1999, Dow *et al.* 1999, Samson and Terziovski 1999, Rao *et al.* 1999, Ho *et al.*

1999, Curkovic *et al.* 2000b). In recent years this relationship has been the focus of increasing academic interest, and particularly empirically based in nature (Handfield *et al.* 1999, Dow *et al.* 1999, Samson and Terziovski 1999, Rao *et al.* 1999, Ho *et al.* 1999, and Curkovic *et al.* 2000b).

Due to the relationships that the researchers proposed, when the data was analysed different results emerged. For example, research (Saraph *et al.* 1989, Flynn *et al.* 1994, Flynn *et al.* 1995, Joseph *et al.* 1999) which identified one broad construct, quality management (supported by numerous practices), concluded that practising quality management resulted in improved performance. However, researchers that examined the relationship between individual practices and performance identified specific practices which improved performance. Adam *et al.* (1997) concluded that knowledge about continuous improvement, customer focus and management involvement resulted in increased quality improvement performance. Whereas Ahire *et al.* (1996) proposed that top management commitment appears to influence product quality through improved customer focus and effective human resources mobilisation. Forker *et al.* (1996) found that design quality/design innovation and product improvement are strongly related to business performance in the furniture industry. Samson and Terziovski (1999) found that the soft factors of TQM (leadership, people management and customer focus) were strong predictors of performance.

It was decided to analyse the performance measures used by these researchers firstly at a generic level and secondly by using a grouping process (similar to that used previously for quality practices) to categorise the measures. This process involved starting at a generic name level, and since the research to date has examined the link between quality activities and business (financial), plant and/or quality performance, these categories were used as a starting point for the grouping process. Additional categories were included as they appeared in the research. The overview of the performance measures (Table 2.14) shows different approaches to this category in the research. Some researchers grouped the measures into between one and six categories whereas others considered them individually within the research. It can be seen that the total number of measures used by the researchers varies significantly from two to nineteen and also whether subjective, objective or a combination. Unfortunately measures were not the primary aim of the research and often precise details have been overlooked in the publication which explains the gaps in the contents of the table. In addition, the types of measures (business, plant, quality etc) are shown and some research had measures examining only one category (for example, Flynn *et al.* 1995, Madu *et al.* 1996) but most of the work examined looked at several types of performance.

	Saraph *et al.*	Flynn *et al.*	Flynn *et al.*	Adam *et al.*	Powell	Madu *et al.*	Ahire *et al.*	Choi and Eboch	Joseph *et al.*	Anderson and Sohal	Dow *et al.*	Ho *et al.*	Rao *et al.*	Samson & Terzvioski	Curkovic *et al.*
Year	89	94	95	97	95	96	96	98	99	99	99	99	99	99	00b
No of Performance Measure Categories				3	2	1	2	2		2	1	6	2		2
Total No. of Performance Measures	2	2	1	14	13	9	12	19	2	11	4	15	9	7	14
Objective (numeric/value)	1	1	1	2	13	9	10	19	2	?	3	10	9		14
Subjective or perceptual	1	1		12			2			?	1	5			
Performance Measure categories															
Business (financial) performance				X	X	X				X					X
Plant performance		X			X			X		X			X	X	
Quality performance	X	X	X	X			X		X		X	XX X	X	X	X
Customer satisfaction	X							X	X			XX X		X	
Supplier performance							X								
Employee satisfaction				X										X	

KEY: X One performance measure in this category: XX Two measures in this category: XXX Three measures in this category

Table 2.14 Overview of Performance Measures

Research by Ho *et al.* (1999) and Samson and Terziovski (1999) appears to be the most comprehensive as not only do their measures cover multiple performance types but there are also multiple categories of measures designed to capture the performance data. Eleven of the fifteen studies collected quality performance data with six studies collecting plant performance data and five studies collecting data on business performance and customer satisfaction. No study collected data on all three of the key performance measure categories (business, plant and quality performance).

At this generic level, the comparisons are relatively straightforward and indicate similarities, however, if the supporting details are analysed, within each performance measure category, then a different picture emerges. If the research which used two or less measures is compared (Table 2.15) then there are essentially two different measures which have been used: quality performance (subjective) and percent final product without rework (objective).

Saraph *et al.* 1989	Quality performance over last 3 years
Flynn *et al.* 1994	% item shipped without rework
Flynn *et al.* 1995	% parts passing final inspection without requiring rework
Joseph *et al*. 1999	Extent of performance with respect to quality during the last 3 years in the division

Table 2.15 Quality Performance One Objective Measure

Examination of the research that used categories to group performance measures is compared, for example Quality Performance (Table 2.16) then a range of names (where specified) are used to articulate the categories.

Adam *et al.* 1997	Performance Quality		
Ahire *et al.* 1996	Product Quality		
Dow *et al.* 1999	Conformance to specification		
Ho *et al.* 1999	Product Quality	Production Quality	Product quality improvement
Rao *et al*. 1999	Internal quality results	External quality results	
Curkovic *et al.* 2000b	Quality performance		

Table 2.16 Quality Performance: category names

An overview of the actual quality performance measures (Table 2.17) gives an indication concerning the high variety and quantity of measures used by different researchers.

Research	Product Quality	Production Quality	Cost of Quality
Adam *et al.* 1997		• Average % items defective	• Cost of quality (CoQ) as % sales: scrap • CoQ rework • CoQ Inspection • CoQ training & development • CoQ returns/warranty • Total CoQ
Ahire *et al.* 1996	• Relative performance of product in comparison to other products in industry • Relative reliability of product in comparison to other products in industry • Relative conformance of the product to specification • Relative durability of product compared to other industry products	• % scrap generated • % rework	
Dow *et al.* 1999		• % of defects at final assembly • An assessment of the defective rate relative to competitors	• Cost of warranty claims • Total CoQ
Samson & Terziovski 1999	• Warranty claims cost as % total sales	• Defects as a % of production volume	• CoQ (error, scrap, rework and inspection) as % total sales
Ho *et al.* 1999	• Performance • Reliability • Conformance • Durability	• %rework • Scrap rate • Reject rate • % improvement rework • % Imp scrap • % Imp reject	
Rao *et al.* 1999	• Customer complaints • Competitive position • In business • Profits	• Scrap • Rework • Productivity • Throughput time	• Costs
Curkovic *et al.* 2000b	• Product reliability • Product durability • Design quality • Company reputation • Pre-sale cust. service • Product support • Responsiveness to customers	• Conformance to specification	

Table 2.17 Comparison of Multiple Quality Performance Measures

However, although precise details/questions concerning the measures vary, analysis reveals that three key themes emerge:

1. Product quality: this category is the most subjective of the three, as it concerns the products performance, usually assessed in comparison to the competition, often based on the definitions of quality proposed by Garvin (1987). Used by Ahire *et al.* 1996, Ho *et al*. 1999, Joseph *et al*. 1999, Curkovic *et al*. 2000b.
2. Traditional Production Quality: usually specified as % scrap, % rework, % defects at final assembly (reject rate), and such measures are used (Flynn *et al.* 1994 and Flynn *et al.* 1995, Adam *et al.* 1997, Dow *et al.* 1999, Samson and Terziovski 1999, Ho *et al.* 1999, Rao *et al.* 1999).
3. Cost of Quality (CoQ): this has been used to varying levels of specificity by the research. Dow *et al.* (1999) examines Total CoQ, whilst Adam *et al.* (1997) additionally finds out about, CoQ rework, scrap, etc and Samson and Terziovski (1999) uses warranty claims too.

Also sometimes the measures were evaluated subjectively and others gathered objective numeric data. This also confuses the research picture. Managers' perceptions, rating performance against that of competitors, largely subjective and opinion findings indicate that all surveyed companies tend to think that they are at least as good as their competitors. When actual measures have been used, no account has been taken of industry/company differences.

Dow *et al.* (1999) noted that previous research has not considered the validity and reliability of the scales used to measure performance and although the authors addressed this anomaly they found that the construct reliability was low and therefore the content of it, that is the quality performance measures, needs examining.

Although key themes are apparent there is no overall consensus as to which performance measures are to be used. In turn, practitioners do not know which practices are the most effective or how to measure the impact or success of the practices used. Research (Bardoel and Sohal 1999) found that "no company had a comprehensive system for accurately measuring the costs and benefits of TQM. The benefits were only identified on an informal basis."

2.4.5 Quality Practice Conclusions

The quality practice research topic has evolved in order to articulate TQM and enable an investigation into the quality practice performance relationship. A conflicting picture of the number and type of total quality management practices has emerged. Different researchers have identified different quality practices consisting of different items. Therefore:

- There is no agreed overall 'set' of quality practices that form the core of TQM and therefore a quality programme.
- The items within a quality practice are generic themes to reflect the nature and intent of the practice rather than specific quality activities, such as quality tools and techniques (e.g. SPC, QFD etc).
- There is currently no consensus as to which quality practices affect performance. Also, to compound the problem further the performance measures used vary considerably.

The variety of definitions for QM and TQM may have contributed to the different research identifying different quality practices. Some of the origins for the quality practices and their component items are based on quality awards (specifically the MBNQA), yet there has not been a specific intention to link this research strand to either SQM or TQM frameworks more generally. Therefore, the link between quality practices and TQM and SQM theory, has not been examined. In addition a practitioner perspective of the link between quality practices and the management of a quality programme is an interesting, affiliated area for further research.

The generic nature of the quality practices does not readily suggest which quality activities should be used to fulfil them and it is noticeable that the quality practice research has not linked to the quality model research described in section 2.2.2. Therefore further consideration of the link between quality practices and quality activities from a practitioner perspective would be useful, particularly if it could determine how quality practices are operationalised.

This work differs from the research of Ho *et al.* (2001), whose focus in the review of the practice performance research was the precise nature of the relationship and model of it whereas this study is focussed on the detail comprising the practices and performance measures. Motwani (2001) synthesised the practices in order to determine components of quality management (and selected the most frequently occurring) and then recommended performance measures to suit each practice. However, he did not provide any validation of his proposals as the conclusion suggested an implementation sequence for quality management. This work differs as the review of the quality practices is more comprehensive and only considers instruments which have been empirically developed and it has examined the relationship to performance.

Reviews and analysis similar to the work contained here have recently been published (Karuppusami and Gandhinathan 2006, Sila and Ebrahimpour 2002, Sila and Ebrahimpour 2005) yet there does not appear to be any new findings and their synopsis aligns with the work presented. The earlier research by Sila and Ebrahimpour (2002) is a more comprehensive review as it includes all survey based research and did not exclude research that replicated other

studies or research with a narrow focus. However they have noted that only a few researchers suggest linking quality practices and strategic quality planning and propose research that investigates how the strategies are deployed to achieve the required objectives. The later study (Sila and Ebrahimpour 2005) found that the results of their analysis between quality practices and performance did not align with previous research and suggest the existence of mediating variable(s). Thereby supporting the earlier observation about lack of consensus concerning which practices affect performance and the nature of the relationship. They also observed that performance measures with the same name (in different studies) did not necessarily measure the same item and therefore "makes comparison of the effects of TQM factors on performance across different studies difficult" (Sila and Ebrahimpour 2005) and continue to argue that it may be due to companies in different industries, firm size, country. Similarly, Ho *et al.* (2001) concluded "each quality practice contributes to quality improvement in a different way" which suggests that these recent studies, though comprehensive have not significantly added to the debate and neither do they contradict the findings of this review.

In another review of the TQM empirical studies (Karuppusami and Gandhinathan 2006) Pareto analysis was used to identify the vital few critical success factors (CSF's) (referred to as quality practices in this work) which should be included in future empirical research examining the relationship between TQM and performance. However, the analysis was based on a judgemental process of grouping similar CSF's (Karuppusami and Gandhinathan 2006) yet it appears that this was done at the practice name level and did not include closer examination of the contents of each of the variables. As noted earlier, the content varies significantly, and as such the research presented complements the work contained herein but does not extend the theoretical development of this research field.

Recent research is still referring to the key early research (Saraph *et al.* 1989, Ahire *et al.* 1994 and Powell 1995) as a basis for their investigations which are now starting to look at quality practices in context specific situations, for example in SME's (Anderson and Sohal 1999, Claver and Tari 2006), a specific country/region (Claver and Tari 2006, Baidoun 2006), linkages to ISO9000 (Prajogo and Brown 2006, Claver *et al.* 2002) and/or quality awards, or other performance aspects (Prajogo and Sohal 2003) and service organisations (Hasan and Kerr 2003).

It can therefore be suggested that this review is still pertinent as it has examined the quality practices from an original perspective, that is, it is considering the linkages with other aspects of the TQM literature, and through this consideration has identified relevant and pertinent issues.

The next stage of this review is to examine the literature on quality activities, the tools and techniques, in order to establish how this area links to the topics investigated so far.

2.5 Quality Activities

The quality practice research (section 2.4) identified generic statements to articulate the components of TQM and therefore where organisations should focus their quality efforts. However, this research did not provide suggestions concerning what should or could be done to operationalise these quality practices and nor did it provide linkages to other quality theory to support the deployment of the practices. In contrast the TQM frameworks (section 2.2) do provide some guidance as they suggest (unproven) links between TQM principles, practices and tools and techniques and in some cases suggest how TQM can be practiced.

Firstly, some frameworks (Hellsten and Klefsjo 2000, McAdam 2000, Morrow 1997, Boaden 1997, Kanji and Asher 1996, Lau and Anderson 1998) cite "continuous improvement" as a core value/principle/tenet of TQM. Other research (Sim 2001, Tena *et al.* 2001, Claver *et al.* 2002) supports this and also identify continuous improvement as a key ingredient of TQM. Continuous improvement appears to be the main method to improve both quality and performance within a quality programme. Continuous Improvement (CI) has been defined as "an organisation wide process of focused and sustained incremental innovation" (Bessant and Francis 1999). Research (Bessant and Francis (1999), Bessant *et al.* 1994) has presented a model which describes different types of approach and levels of capability in CI and suggests that organisations move through these stages as they develop CI.

Secondly, tools/techniques/activities have been identified by some frameworks (Hellsten and Klefsjo 2000, Morrow 1997, Boaden 1997, Mann and Kehoe 1994, Zhang 2000) and have also been suggested as the way that TQM is specifically integrated into the organisation to improve quality. McQuater *et al.* (1995) provide detailed definitions for tools and techniques:

> "Tools and techniques are practical methods, skills, means or mechanisms that can be applied to particular tasks. Among other things they are used to facilitate positive change and improvements. A single tool may be described as a device which has a clear role. It is often narrow in focus and used on its own. For example, cause and effect diagrams, Pareto analysis, relationship diagrams, control charts, histograms, flowcharts. A technique … has a wider application than a tool. This often results in the need for more thought, skill and training to use techniques effectively. Techniques can be thought of as a collection of tools. For example, SPC, benchmarking, quality function deployment, failure modes and effects analysis, design of experiments".

In particular, the TQM activity model (Mann and Kehoe 1994) classified quality activities into ten categories, which were subsequently grouped into five elements, which the authors suggested TQM was trying to address. Similarly, Zhang (2000) proposed a Quality Management Method (QMM) framework which groups the QMM's into eleven categories based on the different aspects of quality management which they are intended to improve. Closer examination of these models (Tables 2.4 and 2.5) shows that they include a few tools and techniques and more general quality based activities (such as supplier rating, quality policy). However neither researcher attempts to justify or explain how the groups were formed or prove the links between the activity and the category it is intended to support. Terziovski and Samson (1999) believe TQM includes the use of tools and techniques. The use of tools and techniques within the quality improvement process is also advocated (Bunney and Dale 1997).

Early investigations into the applications of tools and techniques focused on different aspects of CI. For example, Bunney and Dale (1997) provide detail of a case study investigation where the deployment of tools is studied over a number of years and provide advice to organisations to make effective use of tools and techniques. Other research (Jha *et al.* 1999) report on the use of CI practices within 4 industrial sectors in Canada. This work in some respects was similar to the quality practice investigations (in section 2.4) as the CI practices were generic and did not examine tools and techniques. In contrast Hyland *et al.* (2000) reported on the usage of specific tools and techniques by organisations in Australia as part of the CI process. They also identified six core abilities for effective CI in organisations and presented a 5 stage development process that organisations move through as their approach to CI matures, however they do not indicate how the movement occurs, only characteristics of the firms at each of the levels. It can be noted that this research is similar to the model prescribed by Bessant *et al.* (1994). Handfield *et al.* (1999) noted that usage of quality tools varies significantly, not only within organisations but also across industries and countries. They examined quality tool deployment across North America and Europe, and by grouping tools, into four categories sort to determine the effects of these different groups on performance. It was found that "quality tool deployment appears to be a prerogative of both quality managers and strategic planning executives" (Handfield *et al.* 1999).

More recently, research (Sousa *et al.* 2005) found in a survey of Portuguese SME's that only 7 from 40 quality tools had a greater than moderate usage. Fotopoulos and Psomas (2008) compared the literature reporting on the application of tools and techniques in various countries reported by a selection of authors (for example from Hong Kong (Lam 1996), Saudi Arabia (Curry and Kadasah 2002), Malaysia (Ahmed and Hassan 2003), Turkey (Bayazit 2003) and Greece (Vouzas 2004) and more, refer to research for comprehensive review) and concluded that the level of use of quality tools and techniques has been explored worldwide. Investigation into the

level of use of twenty tools and techniques in Greek ISO9000 certified organisations found that there was a weakness when it came to implementing tools and techniques for the majority of organisations and a greater use of the tools are required in order to move towards TQM (Fotopoulos and Psomas 2009).

Research (Sohal and Lu 1998, Claver *et al.* 2002, Mehra and Agrawal 2003, Yusof and Aspinwall 2001) has recommended that it is essential to involve employees in CI through the application of tools and techniques. This approach should permeate all levels of responsibility in an organisation (Sohal and Lu 1998, Terziovski and Samson 1999). Some CI research (Bunney and Dale 1997, Mehra and Agrawal 2003, Fotopoulos and Psomas 2009) recommends that continuous improvement, tools and techniques need to be integrated into the everyday processes so that "the job of improving and assuring quality … is the responsibility of everyone" (Mehra and Agrawal 2003). More recently Fotopoulos and Psomas (2008) have advised that further research should investigate the difficulties that companies are experiencing in integrating tools and techniques into their everyday practices.

Mann and Kehoe (1994) defined quality activity as a generic term to describe a distinguishable tool or method used for quality improvement. This definition will be adopted for the purpose of this research and it will include the tools and techniques used to improve quality as part of CI but exclude TQM as an activity in order to avoid confusion with the purpose of this research where TQM is being used to represent an organisational approach to quality, such as a quality programme. Note that this is in contrast to Mann and Kehoe's (1994) explanation which considered TQM as an activity and Zhang (2000) who identified TQM as a QMM consisting of many QMM's.

The focus of this research is not the investigation into which quality activities, tools and techniques should be used but how they are linked to practices by organisations in order to improve quality performance. It has been found that CI is very difficult to implement Jha *et al.* (1999). Therefore, the selection and deployment of quality activities and their relationship and links with quality practices and the organisations' quality programme is the purpose of this research. In addition, employee involvement requires further investigation as it appears that it is a critical element in an organisations quality programme and ultimately improved quality performance.

2.6 Employee Involvement

2.6.1 Introduction

Employee Involvement (EI) has been defined as "the extent to which employees producing a product or offering a service had a sense of controlling their work, receiving information about their performance, and being rewarded for the performance of the organisation" (Lawler *et al.*., 1992). In a review of the perspectives of EI (Ang 2002), it was concluded that it has become a "broad term encompassing an extremely broad range of concepts". Such concepts include the practices of continuous improvement/problem solving, teamwork, information and power sharing, knowledge and training, rewards/incentives and profit sharing (Sumukadas 2006, Pun and Gill 2002, Daily and Bishop 2003). Employee involvement in problem solving and decision making, through an empowered culture is believed to lead to ongoing continuous improvement and ultimately improvements in business performance (Pun *et al.* 2001). Other research (Abdullah *et al.* 2008) established the soft practices of TQM (including employee involvement) lead to quality improvement and increased organisational performance. In this study quality improvement practices included items such as customer involvement, teamwork, supplier involvement, new product quality, however, noticeably only process management and process control related to the manufacturing environment and the specific details of these practices were not detailed. Sun *et al.* (2000) identified a positive link between EI and improved business performance.

However these researchers have focused on what an organisation should be doing to encourage EI whereas the focus of this research is on what employees should be doing as part of EI, in a TQM context. That is, how EI translates into specific day-to-day quality activities which lead to improved quality performance.

2.6.2 EI, TQM and Quality Practices

Earlier work in the literature review (section 2.2.1) examined a variety of definitions for TQM and did not find a definitive prescription. However, many definitions (Ross 1993, Dean and Bowen 1994, Ahire *et al.*1995, Joseph *et al.* 1999, Mehra *et al.* 2001) do refer to the whole organisation in terms of commitment or employee involvement.

Beyond TQM definitions, researchers have created theoretical frameworks/models (section 2.2.2) to articulate TQM (Hellsten & Klefsjo 2000, Ho *et al.* 2001, Kanji and Asher 1996, McAdam 2000, Morrow 1997) and similarly these include reference to employee involvement concepts/practices.

In order to facilitate the adoption/practical implementation of TQM much research has focused on identifying TQM practices and articulating each via a set of items (section 2.4 presents a range of this research). In other complimentary research (Sila and Ebrahimpour 2002) analysed seventy six survey studies published between 1989 and 2000 to investigate TQM research and identify TQM practices. From the twenty five practices identified seven referred to employees: Human Resource Management, Training, Employee Involvement, Employee Satisfaction, Teamwork, Employee Appraisal Rewards and Recognition. Employee Involvement appeared in 63% of articles and was in the top five frequently covered practices. However, unlike the earlier work presented (section 2.4.2), their research did not examine the detail which comprised the factors. It was noted earlier that the same practice names consisted of different items and it was therefore difficult to directly compare findings.

In order to evaluate the different 'employee' quality practices four empirically supported dimensions of employee involvement, i.e. Information Sharing, Knowledge and Training, Pay and Rewards and Power Sharing (Lawler *et al.* 1992, 1995 cited in Sumakadas 2006) have been selected as a benchmark to compare against. This work has been selected because the research has been used for previous comparative studies in the TQM/EI field (Sumukadas 2006) and has been cited by other research in EI/TQM (Sun *et al* 2000, Ang 2002, Pun and Gill 2002, Karia and Asaari 2006). Three studies have been selected for comparison (Table 2.18) as their analysis demonstrates some depth of description concerning the TQM practice, 'employees'. For example Rao *et al.*'s (1999) employee practice is called Employee Involvement. Whereas Samson & Terziovski (1999) name the practice People Management and Brah *et al.* (2002) state Human Resource Focus. Only Rao *et al.* (1999) cover all of Lawler's dimensions of employee involvement and that the number and content of items each of the researchers use to articulate each dimension differs. It should be noted that the EI practice and associated items give generic indications concerning what an organisation should do to foster employee involvement in the broadest sense rather than how employee involvement may manifest itself in quality activities.

This is mirrored in other research Pun *et al.* (2001) have identified practices at a strategic and tactical level that an organisation should adopt and implement, for example, common goals, communication skills, problem solving skills. A number of studies have been conducted and presented which have focused specifically on production workers (Lam 1996, Karia and Asaari 2006, Ooi *et al.* 2007, Ooi *et al.* 2008) and the effect TQM has had on their jobs, particularly with regard to job satisfaction, job involvement and organisational commitment. None of these studies considered the specifics of an individuals' job but focused on generic descriptions of quality practices and employee involvement, consistent with the literature already presented.

	Information Sharing	Knowledge and Training	Pay and Rewards	Power Sharing
Rao *et al.* (1999) **Employee Involvement**		• Quality awareness building among employees is ongoing.		• Employee involvement programmes are implemented in the company / division. • Hourly / non-supervisory employees participate in quality decisions. • Employees are held responsible for the output of their process. • Company / division measures employee morale.
Samson and Terziovski (1999) **People Management**	• Our site has effective 'top-down' & 'bottom-up' communication processes.	• The concept of internal customer is well understood at this site. • We have an organisation-wide training and development process, including career path planning for all our employees. • Employee flexibility, multi-skilling & training are actively used to support improved performance.	• Our occupational health & safety practices are excellent.	• Employee satisfaction is formally and regularly measured. • All employees believe that quality is their responsibility.
Brah *et al.* (2002) **Human Resource Focus**	• Our company has effective 'top-down' & 'bottom-up' communication process.	• We provide training in quality principles, such as team building, problem solving, data analysis & statistical techniques.		• We use specific organisational structures like quality circles & cross-functional teams to support quality improvement. • Employees' suggestions are formally & regularly evaluated. • Our line workers inspect their own work and are given the resources necessary to correct quality problems they find.

Table 2.18 – A Comparison of TQM Practice 'Employee" against Dimensions of EI

Research has not indicated how EI could be incorporated into an individual's day-to-day job or what can be done to combine quality activities and EI at an operational level.

2.6.3 Employee Activities

Research (Adam 1992) asked "from where, though, does all the extra effort necessary to achieve this desired quality level come?" and continued to note that "the task becomes one of assessing the human effort at all levels and for all jobs … and then should some capability be unused, getting employees to strive for higher quality performance in all activities". McGee (1993) identified the need to make changes to individuals' day-to-day activities in order to integrate quality responsibilities alongside the main job to achieve TQM. Another early survey study (Ebrahimpour and Withers 1992) found that although organisations considered production employee's responsibility for quality as important, the actual delegation of responsibility and use of statistical quality control tools was inconsistent. Irani *et al.* (1997) believe TQM should "profoundly influence the working practices of individual employees".

There has been some limited research into the details of an employee's day-to-day activities. Yeh (2003) believes employees need to participate in "extra-role behaviours, e.g. continuous quality improvement activities" (within their day-to-day activities). Similarly Kehoe (1996) argues that people have two jobs, firstly, the work they do and secondly looking for ways to improve that job.

A few researchers and industrialists believe that individuals' activities comprise of two main components, three examples of this are:

- value adding/non-value adding (Trump 1993);
- prescribed/discretionary (Wickens 1993);
- direct/indirect (Goodyer 1998).

Consistent with the work of Kehoe (1996) and Yeh (2003), the above authors recognise a need to design and focus upon non-value adding/indirect/discretionary elements of an individual's activities in order to achieve quality performance improvements. However, none of this previous research has identified which activities should be performed or how the activities could be incorporated and managed as part of an individual's job.

Indeed, the importance of such detailed knowledge concerning operational activities is very important to companies particularly the day-to-day elements of employee involvement (Ang 2002). In addition, Ang (2002) argues that the plethora of typologies and descriptions reveals a lack of consensus among researchers with regard to how employee involvement programmes may be contextualised and structured for day-to-day implementation in an organisational setting.

2.6.4 EI Conclusion

Despite a variance in terminology, it is apparent that when TQM is being investigated and articulated EI is a critical factor and is clearly linked to TQM. It is also clear that although EI comprises differing descriptions for the same practice EI is essentially about engaging employees in proactively improving the business. This statement is supported by Silos (1999) who states that the concepts of Total Employee Involvement, Kaizen, Employee Suggestion Programmes, Employee Empowerment and Teams are all equivalent to EI because "they all involve the participation of employees in decision making and problem solving in the area of business improvement". Although EI as a quality practice is an essential element of TQM, it has predominantly been investigated in terms of the existence of generic "soft" items which comprise the practice.

However, a link has not been made between EI practices and quality activities (tools and techniques). In addition, there is a need to examine individuals' jobs in more detail so that quality activities can be incorporated into them at an operational level. Therefore, research is required that will focus on an individual's day-to-day activities and provide a method for integrating quality activities so that improved performance can be achieved.

2.7 Critical Review and Conclusions

The purpose of this critical review is to compare and synthesise the conclusions generated during the literature review in order to produce a detailed research proposal for further investigation which aligns with and supports the research aims and objectives in Chapter 1. A number of gaps in the literature have been identified, and when combined enable a research agenda to be formalised.

Firstly, a selection of definitions has been presented for quality, quality management and total quality management (TQM). Then a variety of prescriptions/models/frameworks which have been developed to articulate TQM were offered. Although the diversity has been noted as a strength as it enables practitioners to adopt messages which suit their business needs, it is also an indicator that the research field is still in the theory developing stage. The models offer different perspectives of TQM, some generic and managerially orientated whilst others focus on operational approaches to the topic. The detail presented also varies from overview to specific and although relationships and linkages have been implied they have not been justified or validated. However, three main elements emerged from this review, and suggested that TQM comprised of: values/tenets/principles at a strategic level; quality concepts or practices designed to fulfil the strategic level principles; and quality tools and techniques which become the specific activities employees engage in at an operational level. These levels align

with the strategic, tactical and operational levels suggested by Leonard and McAdam (2002b), although their work did not specifically link with the existing TQM models and frameworks. This finding guided the remaining part of the literature review, to examine these levels and investigate linkages between them and existing theoretical frameworks.

Strategic Quality Management (SQM) has evolved to link TQM and strategy and in some respects emphasises the dynamic nature of TQM which has emerged. The need to manage an organisations quality programme progress as it adopts TQM and evolves has been shown to become more strategic in nature as the organisations approach matures. Quality Awards, the Balanced Scorecard, Hoshin Kanri and Quality Function Deployment were identified as suitable SQM techniques, particularly the latter three as they could facilitate the deployment of the strategic values/principles of TQM. However, the strategic nature of quality programmes has not been explored from a practitioner perspective by research.

The variety of definitions for QM and TQM may have contributed to different research identifying different sets of quality practices which comprise TQM. Therefore identifying which quality practices are most commonly engaged in by practitioners is an investigation opportunity. Some of the origins for the quality practices and their component items are based on quality awards (particularly the MBNQA), yet there has not been a specific intention to link this research strand to either SQM or TQM frameworks more generally. Therefore, linking quality practices to the TQM and SQM theory, particularly from a practitioner perspective is another research opportunity. The items within a quality practice are generic themes to reflect the nature and intent of the practice rather than specific quality activities, such as quality tools and techniques (e.g. SPC, QFD etc). In addition these items vary across research even when the practice name is the same the research articulates the practice to various degrees of thoroughness. In view of the generic nature of the quality practices, how do they enable quality to be operationalised and their link to specific quality activities, the tools and techniques can be investigated further. What are the quality activities that constitute a quality practice when a practitioner standpoint is considered? Finally, there is currently no consensus as to the relationships between the quality practices or more importantly which quality practices lead to improved performance. Also, the complexity is enhanced because the performance measures used vary considerably, even though they could be grouped into three broad categories: product quality, production quality, and cost of quality.

The practical operational elements of TQM have been largely overlooked in the quality research. Only two researchers attempted to group some of the tools and techniques against the practices. The TQM definitions and frameworks/models identified continuous improvement (CI) as the operationally focused principle of TQM. Although as previously noted a mature approach to CI requires it to be integrated with a strategic approach. Some frameworks specifically identified tools and techniques as the method of incorporating TQM into an

organisation yet only suggested at best tentative links whilst other research has suggested that the use of tools and techniques is essential for organisations adopting TQM. The use of tools and techniques to support CI has been defined as quality activities. The selection and deployment of quality activities by practitioners to fulfil quality practices requires further investigation. Do practitioners link the application of quality activities to quality practices and then to SQM?

Employee Involvement has been identified as a key ingredient of TQM and identified as enabling improved performance. EI encourages quality to be the responsibility of everyone. However, EI research has identified generic practices which comprise EI and has not investigated a link between EI and quality activities at an operational level. Investigating individuals' day-to-day job from an EI and quality activity perspective (the indirect/non value adding time) with a view to integrating them is an opportunity for further research.

According to Leonard and McAdam (2004) "there is a need for evaluative models of TQM, which address the dynamic effects of TQM at strategic, tactical and operational levels". Therefore based on the findings from the literature review and this critical analysis a model (Figure 2.8) is proposed:

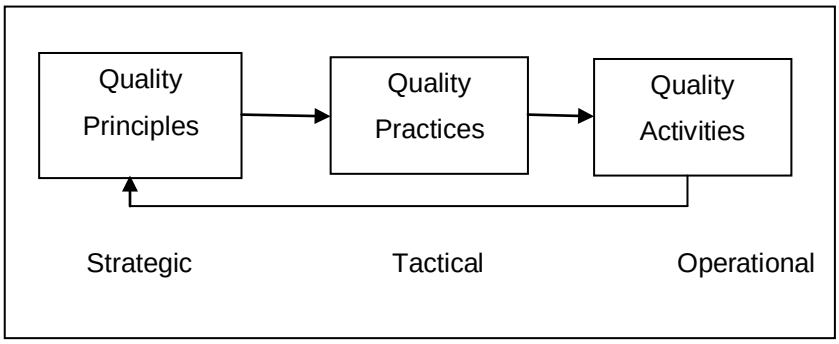


Figure 2.8 Research Model proposed

It is suggested that quality principles, through SQM, is the strategic level and an organisations quality aims and objectives for these principles are used to determine and drive the quality practices. It is also suggested that quality practices exist at a tactical level and are translated by management into specific quality activities. The quality activities are performed at an operational level by individuals. Quality principles, quality practices and quality activities together comprise an organisations quality programme or also known as approach to TQM. It is suggested that organisations evaluate the effects of the quality activities through performance measures and this feedback creates a dynamic approach to TQM.

This research will examine this model from a practitioner perspective and investigate the nature of not only these three elements of the quality programme but also the linkages

between the parts and any feedback which may exist. Therefore, the selection and deployment of quality activities through employee involvement, and their relationship and links with quality practices and the organisations' quality programme is the focus of this research

2.8 Chapter Summary

This chapter has presented a synopsis of the total quality management (TQM) theory and found that there are many definitions of quality, quality management and total quality management. This diversity has led to the development of a mix of total quality management models and frameworks. These suggest that TQM comprises three levels: principles (at a strategic level), practices (at a tactical level) and activities (at an operational level).

Strategic quality management (SQM) has been identified as a necessary method for companies wishing to develop a mature approach to TQM and a selection of frameworks were presented which could be used for this purpose.

Research has been presented which has empirically investigated the quality practices which comprise TQM. This found that there is not a standard set of practices and researchers have developed their own sets in order to investigate relationships between practices and make recommendations concerning the key practices of TQM and its' implementation. It was found that the detailed items that comprise the various practices differed with respect to depth and content, even when the practice name was the same.

Quality activities have been defined as tools and techniques used within CI to improve quality. Employee involvement in quality activities, on a day-to-day basis by an individual has not been investigated.

Finally this chapter has identified and justified the topics for this research, particularly focusing on the relationships between these three levels and the practitioner application of them.

3.1 Introduction

A research methodology is required in order to provide a structured approach to the work being conducted. The documentation of the methods used enables the research to be replicated in other studies and provides additional confidence in the results of the research.

There is no one correct method, but the method should be appropriate to the research area. According to Easterby-Smith *et al.* (2002) the types and contexts of research vary so widely that 'ideal' strategies will differ from situation to situation. Similarly, Handfield and Melnyk (1998) state "there is a need to apply different sets of research methodologies as one undertakes various activities".

The literature review (chapter 2) identified that existing research has used surveys to determine the existence of quality practices and the relationship between them, whilst other research has used case studies to report on the applications of specific quality activities, practices and programmes at organisations. However it was concluded that there is a need to focus on the relationship between quality activities and practices within a quality programme as this has been largely overlooked.

This chapter describes and justifies the research methodology used to investigate company quality programmes and quality activities. The research comprises two main elements; the quality programme, quality practices and quality activities and the linkages between these three areas; and the specific detail concerning quality activities and how they are integrated on a day-to-day basis alongside an individual's daily tasks. Therefore the research methodology for each of these elements will be detailed.

3.2 Research Questions

The literature review concluded that further research was required in the area of quality programmes, quality practices and quality activities, and specifically firstly looking at the relationship and linkages between these three topics and secondly examining quality activities in terms of their application at an operational level by an individual. Tentative research questions have been created for each of these two areas.

3.2.1 Quality Programmes, Quality Practices and Quality Activities: Research Questions

From the literature review the following tentative hypothesis has been developed:

Is there a link between company quality management programmes and actual quality activities?

It has been broken down into the following questions:

- Which are the quality practices and activities that comprise a company quality programme?
- How is the company quality programme operationalised?
- What are the aims and objectives of the quality programme and therefore the quality practices and quality activities?
- Is there a link between the quality programme practices and the actual quality activities deployed? Can the link between quality practices and quality activities be mapped to indicate alignment?

The purpose of this exploratory research is to articulate answers to the above questions and hence contribute to the quality practice theory in terms of the relationships between the quality practices and activities and also to provide practitioners with guidance about the linkages.

3.2.2 Operational Quality Activities and Employee Involvement: Research Questions

Although the literature review identified employee involvement as a key component of total quality management, and therefore company quality programmes, the precise nature of the involvement has not been investigated at an operational level, and whether this involvement translates into the quality activities needed to support a quality programme.

This lack of existing research has prompted a number of key questions concerning both the research process and the academic subject:

- What is a suitable method for collecting data concerning the use of quality activities in an individual's day-to-day role?
- What are the quality activities that an individual engages in? Can these be separated from their other tasks, that is, can they be individually identified and analysed?
- Can a set of definitions and framework be created which will facilitate consistent analysis?
- Can the results of such an analysis be used to guide employee involvement and manage quality activities to the benefit of the organisation?

3.3 The Research Approach

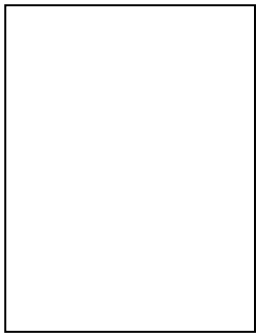
It was stated in the literature review that the majority of the research into strategic quality practices was conducted using large-scale surveys designed to measure management perceptions about a number of quality practices. This research identified strategic quality practices and recently has started to consider the relationships between these practices. Each of these models identified different sets of practices, as shown earlier and summarised in Table 2.10. However the research has tended to overlook actual quality activities, that is, the tools and techniques. Mann (1992) who was developing a TQM implementation framework examined actual quality activities using case study research. Similarly Zhang (2000) developed a model of quality management methods (tools and techniques), structured according to which TQM practices they aimed to improve, which was based on a literature review and tested via case studies. Both studies identified differing TQM quality practices and quality activities. Therefore, in the TQM theory, there is no overall consensus about the set of practices or a model identifying relationships between practices and activities.

There is a need to obtain data from practitioners rather than theory and this real world information is known as empirical data. Gummerson (1991) states “theories concerned with processes in organisations must primarily be generated on the basis of this real data”. According to McCutcheon and Meredith (1993) a prime means of developing well-grounded theories is through empirical, field-based research. Madu (1998) who argues the need for more empirical research supports this stating, “such studies make it possible to relate actual quality practice in organisations to quality theories”.

Therefore this research will examine actual company quality programmes, practices and activities and compare this to the existing theories in order to contribute to the theory mapping and development in this research field.

3.4 Empirical Research

A systematic approach for conducting empirical research is provided by Flynn *et al.* (1990). This is illustrated in Figure 3.1. This method has been selected as the overall agenda for both elements of this research, as it was developed for the Production/Operations Management researcher. Gilgeous (1997) successfully applied this approach. It is felt that it is preferable to select an existing method so that more effort can be spent on the actual research area. Also, a method provides focus and structure to the research programme. Madu (1998) believes that “empirical studies have to be tightly controlled to ensure that the right research questions are being addressed.”



Reliability and Validity considerations underlie all stages

Figure 3.1: A systematic approach for empirical research (source: Flynn *et al.* 1990) (removed for copyright reasons)

Flynn *et al.*'s (1990) empirical research model (Figure 3.1) requires that reliability and validity issues are considered at each stage of the process. This is important because according to Bickman and Rog (1998) "a credible research design is one that maximises validity – it provides a clear explanation of the phenomenon under study and controls all possible biases or confounds that could cloud or distort the research findings". The quality of empirical research can be assessed using the following four tests:
"Construct validity: establishing correct operational measures for the concepts being studied;
Internal validity (for explanatory or causal studies only, and not for descriptive or exploratory studies): establishing a causal relationship, whereby certain conditions are shown to lead to other conditions, as distinguished from spurious relationships;
External validity: establishing the domain to which the study's findings can be generalised;
Reliability: demonstrating that the operations of a study – such as the data collection procedures can be repeated with the same results" Yin (1994).

Reliability issues can also be addressed by adequately documenting the research procedures used so that "two or more researchers studying the same phenomenon with similar purposes should reach approximately the same results. A study with high reliability can be replicated by others" (Gummerson 1991). Therefore, this chapter, by describing in detail the research method used for each of the two elements of the research, fulfils some of the criteria necessary to achieve reliability. Also, as each section of the research method is addressed then the appropriate reliability and validity comments will be noted.

3.5 Research Process: Quality Programme, Quality Practices and Quality Activities

3.5.1 Establish the Theoretical Foundation

Empirical studies can be used to either build theory or to verify theory (Flynn *et al.* 1990). It was shown in the literature review that there is a need to investigate the relationships between strategic quality practices and actual quality activities. This suggests that the focus of this research is theory building. Specifically, according to Handfield and Melnyk (1998) Total Quality Management is "still in the mapping and relationship building stage". The origin for a theory-building study is not a hypothesis, but rather some assumptions, frameworks, a perceived problem or perhaps, very tentative hypotheses (Flynn *et al.* 1990). In the case of this work, section 3.2 described a tentative hypothesis and the perceived problems, based upon the literature review findings.

3.5.2 Selecting a Research Design

Flynn *et al.* (1990) suggests a number of different designs for the research (Figure 3.1). Case study research methodology is one type of empirical approach that aims to develop understanding of real world events (McCutcheon and Meredith 1993). As stated previously, there is a need for case study research that focuses on actual activities, (as opposed to surveys based on management perceptions) to facilitate essential quality practice theory mapping. Also, McCutcheon and Meredith (1993) state "exploratory case studies usually focus on theory development". Therefore an exploratory case study approach has been selected for this research.

Yin (1994) has defined a case study as an objective, in depth examination of a contemporary phenomenon where the investigator has little control over events. According to Easterby-Smith *et al.* (2002) "Robert Yin is probably the best known exponent of this approach" and has several texts published which describe case study methods. In the 1994 book Yin provides a research design for conducting case studies, which enables the researcher "to design more rigorous and methodologically sound case studies". This five-stage process (Yin 2009) consists of: A study's questions; its propositions, if any; its unit(s) of analysis; the logic linking the data to the propositions; and the criteria for interpreting the findings. This above process has been applied within the context of this research programme and the Flynn *et al.* (1990) method, in that, stages 1 and 2 have been addressed in sections 3.2 and 3.5.1 and stages 3, 4 and 5 are addressed in the data analysis section, 3.5.5. In addition, tactics for addressing reliability and validity issues (Table 3.1) are necessary throughout case study research (Yin 2009).

Table 3.1 Case Study tactics for Four Design Tests (Source: Yin 2009) (removed for copyright reasons)

Multiple case studies have been selected as the most appropriate method. Handfield and Melnyk (1998) support this selection, as can be seen from Table 3.2 case studies are the proposed research structure for the mapping/relationship building phase. Multiple case studies have been selected in order to determine "*literal replication"*, that is the cases should enable similar results to be predicted, and according to Yin (1994) a few cases, (two or three) are sufficient.

3.5.3 Selecting a Data Collection Method

Both Flynn *et al.* (1990) and Handfield and Melnyk (1998) suggest a number of differing and complementary data collection techniques. It is increasingly common for multiple techniques

to be used, which is known as data triangulation. McCutcheon and Meredith (1993) believe that “with case research, thorough analysis and data triangulation (use of multiple sources and methods) can help get the most accurate picture of events”. The data collection techniques that will be used for this element of research are structured interviews, questionnaires (completed by the interviewee) and document content analysis. The data collection techniques will be described in more detail in the next section, 3.5.4 Implementation.

3.5.3.1 Triangulation

“the combination of methodologies in the study of the same phenomenon”

Defined by Denzin (1978:291), cited by Jick (1979)

Triangulation refers to the use of multiple methods during a research programme. Ackroyd and Hughes (1992) argue that triangulation encourages a systematic continuity of theory and research and that “by combining multiple observers, data sources, theories and methods, social researchers can overcome the bias that is regarded as inevitable in single-method, single-observer, single theory studies.”

There are four types of triangulation:

1. Theoretical – using models from one discipline to explain situation in another
2. Data – uses data from different sources or collected over different time frames
3. Investigator – different people collect and analyse the data
4. Methodological – the collection and use of qualitative and quantitative data.

Purpose	Research question	Research structure	Examples of data collection techniques	Examples of data analysis procedures
2. Mapping - Identify/describe key variables - Draw maps of territory	- What are the key variables? - What are the salient/critical themes, patterns, categories?	- Few focused case studies - In-depth field studies - Multi-site case studies - Best-in-class case studies	- Observation - In depth interviews - Diaries Survey questionnaires - History - Unobtrusive measures	- Verbal protocol - Analysis - Cognitive mapping - Repertory grid technique - Effects matrix - Content analysis
3. Relationship Building - Improve maps by identifying the linkages between variables - Identify the 'why' underlying these relationships	- What are the patterns or linkages between the variables? - Can an order in the relationships be identified? - Why should these relationships exist?	- Few focused case studies - In-depth field studies - Multi-site case studies - Best-in-class case studies	- Observation - In-depth interviews - Diaries Survey questionnaires - History - Unobtrusive measures	- Verbal protocol - Analysis - Cognitive mapping - Repertory grid technique - Effects matrix - Content analysis - Factor analysis - Multidimensional - Scaling - Correlation analysis - Nonparametric statistics

Table 3.2 Match Research Strategy with theory-building activities. Adapted from Handfield and Melnyk (1998) Table 1

Patton (1990) emphasises the importance of using differing data collection and consequently data analysis techniques and believes that “it is in the data analysis that the strategy of triangulation really pays off”.

Therefore this research uses data triangulation and hence improves the validity and reliability of the research. The use of multiple data sources specifically enhances construct validity.

3.5.4 Implementation

The implementation phase of the research approach outlined by Flynn *et al.* (1990), details the steps for researchers performing a quantitative survey based approach to their research. However, this research is a qualitative case study and therefore the process differs, but effectively covers the design of the data collection phase of the research. This includes the selection of the data samples, methods of data collection and data documentation.

3.5.4.1 Company Selection

There were three criterion that affected company selection:

1. Company must have a well established, externally highly regarded quality programme.
2. Companies should ideally be from different industries.
3. Convenience of conducting case studies.

Since the proposed research questions are focused on examining as many quality practices as possible, companies which use many different quality practices need to be selected. Patton (1990) has defined this as *intensity sampling* where samples are sought that “consists of information-rich cases that manifest the phenomenon intensely”. Following a meeting with a premier business consultant, discussions with colleagues and a review of recent award winners (for example Best Factory Awards, EFQM award (and regional variants)) a number of manufacturing companies were identified. Secondly it was decided to select companies from different industry sectors to maximise the variety in detail of the company quality programme and quality activities, and ensure that it wasn’t an industry specific phenomenon that was being examined. This also means that the results should have increased reliability and validity. This approach gave reassurance to the participating companies concerning the confidentiality of the data they were providing. Finally, a *convenience sampling* strategy was used in order to save time and money, by selecting companies based locally to Coventry and also to facilitate access those companies with whom the research team already had contacts were identified. The short listed companies were invited to participate in the research, firstly by a telephone call and subsequently a document outlining the purpose of the research was sent to them (appendix A2).

Four companies agreed to participate in the research: an automotive OEM (company A), an automotive first tier supplier (company B), an aerospace first tier supplier (company C) and a domestic white goods company (company D).

3.5.4.2 Data Sources and Data Collection

In order to maximise the validity (especially construct validity) of the research through triangulation, three different data sources were employed: an interview, a questionnaire and documentation. Firstly each company was visited and a senior manager/director with responsibility for quality was interviewed. During the course of this interview if the interviewee referred to any documents, copies of these were requested. At the end of the interview, a questionnaire (explained later) was left for the interviewee to complete and then return to the researcher. In addition, if the interviewee was particularly interested in the topics, a follow up meeting was requested, with another member of the company with responsibility for quality. Companies A, B and C were visited twice. The purpose of the second meeting was to gain additional information about the quality programme and quality activities used and hence increase confidence in the first set of data. Each meeting was designed to last approximately two hours.

Interviews

According to Yin (1994) interviews are one of the most important sources of case study information. Interviews permit the researcher to ask questions appropriate to the research topic in order to find out rich data, including new information, dimensions and opinions from the respondent's perspective concerning the enquiry. These responses are the raw data for analysis.

Ackroyd and Hughes (1992) have classified interviews according to the degree of standardisation, as structured, semi-structured and non-standardised. In using structured interviews, the interview schedule and questions must be strictly adhered to for all respondents. Opposite to this is the non-standardised interview where the interview format resembles a conversation and the interviewer can ask questions freely. The semi-structured interview approach combines both methods. Patton (1990) calls this method the general interview guide approach where the guide "serves as a basic checklist during the interview to make sure all relevant topics are covered". Easterby–Smith *et al.* (2002) advocate the use of a checklist that also is used as a "loose structure for the questions". The questions are open-ended and permit the interviewer to modify the questions and lines of enquiry as the interview progresses to investigate emerging themes yet remain focused on the subject area. This

approach enables the interviewer to phrase questions to suit the interviewee and the context of the interview situation.
In designing interviews it is necessary to overcome (as much as possible) the inherent weakness of that data source. According to Yin (2009) (Table 3.3), bias is the main weakness, although poor recall and poor or inaccurate articulation have also been cited.

Source of Evidence	Strengths	Weaknesses
Interviews	• targeted – focuses directly on case study topics • insightful – provides perceived causal inferences and explanations	• Bias due to poorly articulated questions • Response bias • Inaccuracies due to poor recall • Reflexivity – interviewee gives what interviewer wants to hear

Table 3.3 Adapted from Yin (2009) Six Sources of Evidence: Strengths and Weaknesses

The guidelines described by Patton (1990) have been followed in order to address bias as a result of poorly constructed questions. In addition, where the company permitted, a second interview was conducted with another member of the quality department and this approach has helped overcome response bias and hence also aid data validity and reliability. Yin advises corroborating interview data with data from other sources and this has been accounted for in this research design.

In summary, a semi-structured, open-ended interview, which used an interview guide, was used to gather data regarding the hypothesis and research questions described previously in section 3.2. A copy of the interview guide is contained in appendix A3.

Questionnaires

McCutcheon and Meredith (1993) believe that where enough background theory already exists a standardised survey can be used within a case study organisation. Given the large number of surveys that have been developed to date to investigate and measure quality management practices it was considered that one should be selected and used in this research programme. The main reason being that it will enable a judgement to be made concerning the links between the quality theory developed in this research and the existing research – that is, are they linked, and if so, how? The collected survey data can be compared to the interview and documentation analysis results. It will also facilitate consistent within case analysis and cross case analysis.

The existing questionnaires have already been summarised in the literature review however it is now necessary to select one for use in the case studies. This was done using the following 3-step approach:

1. Review the papers which investigate the quality management practice performance relationship (using Table 2.9) and firstly eliminate those that do not identify the survey questions e.g. Adam *et al.* (1997) and Dow *et al.* (1999).
2. Eliminate those surveys that provide only limited coverage of the quality management practices (for example, Madu *et al.* 1996 and Choi and Eboch 1998), as the purpose of this research is to find out as much as possible about the companies' quality practices.
3. Compare the remaining research, looking at the advantages and disadvantages of each with regard to the content coverage and application (summarised Table 3.4).

Authors	Advantages	Disadvantages
Saraph *et al.* (1989)	• Pioneer survey • Manufacturing and service companies	• No customer focus (main tenet of TQM) • Old • Small sector of US
Flynn *et al.* (1994)	• Multi-respondent design, need company backing for use • Manufacturing focus	• Survey designed for respondent profile • No training or role of quality dept • 3 US industries only
Powell (1995)	• Broad topics	• Includes tools e.g. SPC • No product design or role of quality department • Only 4 items per survey scale
Ahire *et al.* (1996)	• Broad topic coverage	• A few tools included • No role of quality department • Manufacturing and Service companies in NE US
Joseph *et al.* (1999)	• Newer, modern version of Saraph survey	• India specific manufacturing companies • No customer focus
Ho *et al.* (1999)	• Modern analysis techniques, but not relevant to this research analysis	• Used Saraph original model
Rao *et al.* (1999)	• Multi country focus • Manufacturing only • SEM analysis techniques used to justify survey content	• No role of quality department • Process and product design merged

Table 3.4 Comparison of Quality Management Questionnaires

An overview of the surveys short listed for use is provided (Table 3.4). In the literature review, the majority of authors identify the importance of focusing on customer requirements and customer satisfaction is a key theme of many TQM definitions. Therefore the questionnaires by Saraph *et al.* (1989), Joseph *et al.* (1999) and Ho *et al.* (1999) have been eliminated, as they do not contain customer focus. The Powell (1995) survey was eliminated on the basis

that firstly it did not contain product design, and many organisations and proponents of TQM recognise that quality must be designed into products. Secondly, the scale items only contained up to four items and also referred to specific quality tools. Data concerning specific tools was to be solicited via the interview and documentation. Although the Flynn *et al.* (1994) survey was missing the practices of training and role of the quality department, these areas are not seen as essential to TQM. However, the fact that the survey is specifically designed so that different respondents answer different scales items means that the questions designed for the individual with senior responsibility for quality are very limited. This is particularly a problem as access to people in the case study companies is very limited and there is a need to gather as much information as possible from the people interviewed. This leaves the surveys developed by Ahire *et al.* (1996) and Rao *et al.* (1999). Neither surveys contain the role of the quality department and the Rao *et al.* (1999) work combines product/process design. Although the survey by Rao *et al.* (1999) uses a scale called benchmarking, it examines the practice from a strategic perspective. This is in contrast to the Ahire *et al.* (1996) benchmarking scale, which assesses the benefits of actually applying benchmarking and also includes an examination of the use of SPC. Since the interviews and documentation will be used to gather data on the use of quality tools and techniques and the Ahire *et al.* (1996) survey duplicates this, then the Rao *et al.* (1999) survey is considered to be more suitable as it avoids repetition. In addition the authors compare their work to that of Saraph *et al.* (1989), Flynn (*et al.* 1994) and Ahire (*et al.* 1996), in which their model compares favourably, for more detail refer to their research. Ahire *et al.* (1996) recommend blending their instrument with the earlier Saraph *et al.* (1989) and Flynn *et al.* (1994) models in future work. This is essentially what Rao *et al.* (1999) did, but in addition their survey was tested in an international context and so has higher external validity. Therefore, it is more suitable for use at UK companies. Also, it is one of the most recently published surveys. Finally, Rao *et al.* (1999) argue their survey will be useful to researchers who are “conducting comparative studies of quality practices”, as in this research programme.

Documentation

Documents should be used in case studies to provide additional evidence which can support and corroborate data from other sources. According to Patton (1990) documents are particularly rich sources of information about programmes specially as they contain information about decisions, activities and processes and they can also prompt questions. Yin (2009) identifies a number of strengths and weaknesses associated with documentation (as shown in table 3.5).

Source of Evidence	Strengths	Weaknesses
Documentation	• Stable – can be reviewed repeatedly • Unobtrusive – not created as a result of the case study • Exact – contains exact names, references and details of an event • Broad coverage – long span of time, many events, and many settings	• Retrievability – can be difficult to find • Biased selectivity, if collection is incomplete • Reporting bias – reflects (unknown) bias of author • Access – may be deliberately withheld

Table 3.5 Adapted from Yin (2009) Six Sources of Evidence: Strengths and Weaknesses

During the interview documents were requested to provide additional and more accurate information than that being verbally given. This would, in addition, provide extra support to the research question.

3.5.4.3 Data Collation, Documentation and Storage

Once the case study evidence has been collected it must be properly managed in order to facilitate analysis (because this raw data is the basis for any conclusions and research implications) and also address data reliability and validity issues. According to Yin (1994) there are three principles which should be followed in order to achieve maximum benefit from the evidence collected. These are:

1. Use multiple sources of evidence.
2. Create a case study database.
3. Maintain a chain of evidence.

The case study primary evidence is in the form of tape-recorded interviews, company documentation and a questionnaire completed by the interviewee. These multiple sources of evidence enable data triangulation (as described previously in section 3.4.3.1) which promotes the convergence of evidence to corroborate facts and phenomenon. This was also supported by the use of a second interviewee (where permitted) which provided additional evidence from each of the three data sources. In addition, as mentioned earlier it also facilitates construct validity, “because the multiple sources of evidence essentially provide multiple measures of the same phenomenon” (Yin 1994).

The main advantage and purpose of a formal structured and presentable database is that other researchers can review it and this increases reliability. A case study database has been created that consists of four sections, one for each company. Within each section the evidence contained includes; interview tape recording, transcribed interview quotes, interview notes, post interview thoughts/observations, company documentation, completed questionnaire and questionnaire analysis table. It should be noted that due to resource

limitations the whole interview was not always fully transcribed. This only occurred on limited occasions providing the omission did not affect the context of the interview or omit data relevant to the research theme. For example, if the interviewee digressed or provided additional product related examples in order to repeat explanations then these were omitted. Although it is recognised that fully transcribed interviews are preferred, Patton (1990) argues that "only those quotations that are particularly important for data analysis and reporting need be transcribed".

A chain of evidence enables an external researcher/reader of the case study to trace conclusions back through to the primary evidence and in the opposite direction. This is facilitated by citations in each of these areas that cross-reference sufficiently. Similarly, when the interviews were transcribed, a number was recorded which relates the section of the tape recording to the quote. According to Yin (1994) this traceability increases reliability and construct validity, therefore "increasing the overall quality of the case".

3.5.5 Data Analysis

Data analysis consists of examining, categorising, tabulating or otherwise recombining the evidence to address the initial propositions of a study (Yin 1994). This is why McCutcheon and Meredith (1993) believe that data analysis is a critical and difficult phase. The analytic strategy adopted should be documented (Yin 1994, Patton 1990) not only to provide guidelines but because an indication of the researchers' thoroughness bolsters confidence in the findings or indicates shortcomings that may prompt questions about the resulting theory (McCutcheon and Meredith 1993). According to Miles and Huberman (1994) data analysis consists of three concurrent stages:

1. Data Reduction – the process of selecting, focusing, simplifying, abstracting and transforming the data that appear in written up field notes and transcriptions.
2. Data Displays – an organised, compressed assembly of the information that permits conclusion drawing and action
3. Conclusion Drawing/Verification – deciding what things mean, noting regularities, patterns, explanations, possible configurations, causal flows and propositions, then verifying through checking back to case notes or replicating findings.

Firstly though, the unit of analysis must be determined (Yin 1994, Miles and Huberman 1994). For this research programme, the unit is the company quality programme. The data from the different respondents will be used to determine the programme details at each company. The use of multiple respondents in this manner enhances construct validity. In addition the data can be analysed from the perspective of within case (analysis within the case) or cross case (analysis between cases). According to Patton (1990) a study can include both types but they should not be done together to avoid confusion.

For this research, the strategy adopted will start with within case analysis, describing the quality programme, practices, activities and the link between them, using data reduction, data displays and conclusion drawing/verification techniques. Finally a cross case analysis of the case studies will be conducted, focusing on the interpretation of the data to draw conclusions and verify them as appropriate.

To facilitate the within-case analysis process, the Content Analysis method has been selected. Handfield and Melnyk (1998) suggest this method as shown earlier (Table 3.2). The main benefits of content analysis are that it facilitates data reduction and the use of categories facilitates comparison of the different cases. Content analysis, according to Flick (1998) is one of the classical procedures for analysing textual material, no matter where this material comes from. The three different data types collected from the case study companies are all suited to this method. Content analysis has been defined as a process of identifying, coding and categorising the primary patterns in the data (Patton 1990). It is ideal for use when it is necessary to analyse subjective viewpoints collected with semi-structured interviews (Flick 1998). Miles and Huberman (1994) describe a number of alternative coding methods; although the techniques selected are descriptive codes for the quality practices and activities used by the company and pattern codes which are used interpretively to identify themes, causes/explanations, relationships and more theoretical constructs. Whilst some codes were predetermined from the literature and research questions it was important to allow new codes to emerge from the data. All the codes used can be found in the case study database. The coded interview text can be found in the case study database too.

Data displays were then generated from the coded data. Matrices to record the data in a tabular form have been used, especially for quality practices and activities, specifically the checklist matrix and role ordered matrix (Miles and Huberman 1994) have been used. Networks have been used to map the links and examine the overall quality programme relationships. These have also followed the guidelines suggested by Miles and Huberman (1994).

“The purpose of cross-case analysis is to look for underlying similarities and constant associations … compare cases with different outcomes and begin to form more general explanations” (Miles and Huberman 1994). According to McCutcheon and Meredith (1993) the commonalties and differences across the varied settings help to outline the patterns upon which to develop the theory. A pattern-matching logic (Yin 1994) will be used to combine the data displays from the different case studies in the form of a matrix for coded data and a network diagram for the quality programme linkages. These displays will directly link the case study data to the research propositions. Finally this data will be reviewed to interpret the findings to determine the research outcomes with respect to the research propositions.

3.5.6 Publication

Once the data analysis phase has been completed, the research findings should be formally documented in a report. This formal write-up of the within case analysis is contained in the Case Study Report and summarised in Chapter Four and follows the "linear-analytic structure" defined by Yin (1994). Each case study company has an individual within case analysis report (Cooke 2010) containing the descriptive narrative, analysis, interpretation, conclusions and implications. The cross-case analysis is documented, in Chapter 4, and includes comparisons and contradictions between the individual case studies as well as the identification of key patterns in the data. Finally areas for future study are identified, as is the purpose of exploratory case studies.

3.6 Empirical Research Process: Operational Quality Activities and Employee Involvement

This section details and justifies the research methodology used for the investigation into operational quality activities. As with the first part of the research the Flynn *et al.* (1990) systematic approach has been used to guide the development and generation of the research methodology. There is also some overlap between the theoretical underpinnings of the first phase of the research and this second phase as both have adopted a case based approach.

3.6.1 Establish the Theoretical Foundation

Research to date has not examined the precise nature of individuals' activities within a manufacturing organisation, specifically from a quality activity perspective, and how these quality activities integrate with the rest of an individuals' day-to-day role. This indicates that this research is also theory building in nature. The perceived problems emerged from the literature review (section 3.2).

3.6.2 Selecting a Research Design

It is essential that this element of the research process enables in depth data to be obtained and an exploratory case study has been selected to help with the theory mapping, development and relationship building required. Yin's (2009) five stage research design process for case studies has again been followed; the study questions and propositions (outlined in section 3.2), the unit of analysis, logic linking data to propositions and criteria for

interpreting findings are detailed in section 3.6.5. Validity and reliability will be considered during the articulation of the research process.

This part of the research study comprised two separate case studies. The first case study became a pilot study, as it tested the research methods and led to development of the research methods and some theoretical ideas. In essence this first case study was in uncharted territory. The outcomes were tested in the second case study which led to theoretical refinement and recommendations for future research and investigative practices of this nature. Studies 1 and 2 together will ultimately facilitate analytic generalisation (Yin, cited in Bickman and Rog 1998) where it is possible to use "cases to illustrate, represent or generalize to a theory".

3.6.2.1 Study 1

A descriptive case study (Bickman and Rog 1998) has been selected as the detailed investigation into individuals' activities (particularly quality activities) requires a significant amount of rich contextual data, which describes how an individual spends a working day and what is being done. This descriptive study has an exploratory intent since the purpose of the study is to evaluate the data collection method, accessibility to data, and data analysis methods, as well as start theoretical development. This embedded case study comprised two individuals (units of analysis) and each of their many activities formed sub units of analysis.

3.6.2.2 Study 2

Case study 1 led to the creation of a tentative set of definitions, a proposed framework and a research data collection approach that required further testing, using a larger sample of individuals in order to refine and complete the theory building phase of the research. Again an embedded case study approach was adopted, but this case study comprised an in depth field study (Handfield and Melnyk 1998) using multiple cases (individuals) and therefore a greater variety of activities would be available for analysis.

3.6.3 Selecting a Data Collection Method

A variety of data collection techniques were considered; documentation, archival records, interviews, direct observation, and participant observation (Bickman and Rog 1998) were reviewed and considered, from a singular perspective and/or a multiple technique approach (with a view to triangulation). The desire for detailed contextual information describing every activity undertaken by an individual guided the selection towards observation and subsequent independent documentation by the researcher. Handfield and Melnyk (1998) also suggest that

observation is a suitable data collection technique (Table 3.2). Yin (2009) identified and compared direct observation and participant observation (Table 3.6).

Source of Evidence	Strengths	Weaknesses
Direct Observation	• Reality – covers events in real time • contextual – covers context of "case"	• time consuming • selectivity –broad coverage difficult without team of observers • reflexivity – event may proceed differently because it is being observed • cost – hours needed by human observers
Participant Observation	• (same as above for direct observations) • Insightful into interpersonal behaviour and motives	• (same as above for direct observations) • Bias due to participant observers' manipulation of events

Table 3.6 Adapted from Yin (2009) Six Sources of Evidence: Strengths and Weaknesses

The strengths of the observation techniques which are critical to the success of the investigation outweigh those weaknesses which can be designed out of the research process. Participant observation was selected as the most appropriate data collection technique. The study design intention is to only observe and not manipulate events and therefore it is envisaged that activities would not differ due to being observed. According to Waddington (2004) participant observation allows "the observer to study first-hand the day-to-day experience and behaviour of subjects in particular situations, and, if necessary, to talk to them about their feelings and interpretations". Validity can be perceived as an issue in this type of research as in some research designs the focus is on perceptions, behaviours and attitudes of individuals which can lead to subjective interpretations. However, in both studies the research focus is the specific activities the individual is engaged in and is therefore factually based data which alleviates the validity issues. Also, participant observation needs to address reliability issues, that is, are the findings genuine and not based on chance. Not only are the activities performed by the individual within the "control" of the manufacturing environment and lacking the free play context typical of this type of research method, but the observations were checked with the individual under observation for accuracy.

3.6.3.1 Study 1 Data Collection

Study one only used participant observation to collect data. The researcher adopted the role of "observer-as-participant, who maintains only superficial contacts with the people being studied (for example by asking them occasional questions)" Burgess (1984), cited in

Waddington (2004). Data was captured based on the Hierarchial Task Analysis technique (Kirwan and Ainsworth 1993). The aim of this study was to test and develop the primary data collection technique (capturing and documenting every single activity that was actually being done) and form initial theoretical beliefs based on early data evaluation and analysis. Therefore it was considered that additional data collection techniques would not benefit the pilot study, but that further data sources would be necessary in study 2 as a pre-requisite to triangulation.

3.6.3.2 Study 2 Data Collection

Participant observation is the primary data collection technique selected for case study two, and in this study the role became the "participant-as-observer, who forms relationships and participates in activities but makes no secret of intention to observe events" Burgess (1984), cited in Waddington (2004). This slightly different role was adopted as a consequence of this study being in-depth, longitudinal and being able to be immersed in the company. This was beneficial to the research as access to meetings, informal conversations, documents and other archive data was possible. Therefore triangulation was facilitated along with a greater depth and perspective for the analysis phase which enhances the reliability of the research. The validity of this research was also addressed as the main participant observation data was corroborated with the person being observed to ensure the recordings were factually accurate. This had the added benefit of removing any perceived "threat" from the observer and helped form a positive image, developing confidence and trust.

3.6.4 Implementation

The implementation phase details the data collection phase: selection of data samples; methods of data collection; and data documentation.

3.6.4.1 Company Selection

Criterion that affected the selection of the companies is similar to those outlined earlier in section 3.5.4.1 pertaining to the other phase of the research:

1. company must have a well established and preferably externally highly regarded quality programme
2. convenience of conducting case studies
3. access to data and trust between the organisation and researcher.

Again, intensity sampling was a pre-requisite, particularly in the pilot study, as quality activities must be practiced by individuals in order for them to emerge from the research. Convenience sampling, by way of location close to Coventry, is particularly important for the longitudinal

study, in order to maximise the time in company and save time and money. However, the most important factor in this research is access to the data. Participant observation, particularly during a longitudinal study requires significant trust between both parties, even with a confidentiality agreement in place.

Study One used an aerospace company located in the Midlands which had recently won the West Midlands Quality Award and were keen to promote their best practices across the region. Although unrestricted access and note taking was possible once on site, the observation visits were limited to two single days although they were preceded by a short meeting with the Managing Director.

Study Two was based in an aerospace company located in close proximity to Coventry and one where the researcher had extensive contacts. This company is a first tier supplier to the aerospace industry and holds many quality approvals. However, due to a highly unionised workforce the researcher was located at a new fringe manufacturing module (cell), which although on site was considered low key enough for the researcher to work without causing concern. Confidentiality was a significant issue due to the type of manufacturing process and in addition the manufacturing process was deemed high risk in terms of health and safety, which limited access to certain areas of the manufacturing cell.

3.6.4.2 Data Sources and Data Collection

In Study One, the only data collected was that from the participant observation. On each of the days spent in the organisation a different individual was observed; firstly a manufacturing operative/assembler, called a team member; and secondly a manufacturing team leader who had production and organisational/management responsibilities for a small manufacturing cell.

During Study Two access to a greater variety of data was possible. Documentation in the form of policy statements, quality procedures, work instructions could be accessed and viewed at any time. Attendance at cell meetings and access to local performance data and management issues was possible when on site. Observing day-to-day ongoing work practices to build up a picture of cell operations and normal practices was complimented by the occasional recording of quality activity related facts. This evidence retrieval and documentation was all geared towards gaining a fuller context and support for the data obtained from the participant observation. Informal unstructured non recorded interviews to establish the purpose of some activities and gain a better understanding, helped with classification and coding of activities and subsequent data analysis. The primary data came from the direct participant observation, where a full day was spent with each of the following: Module Manager (MM) , Manufacturing Systems Engineer (MSE), Senior Laboratory Engineer (SLE), Production Controller (PC) , Team Leader (a) (TLA) , Team Leader (b) (TLB), and a Senior Operator (SO). These seven

positions were chosen because they covered the range of jobs which exist within the manufacturing cell. It was decided to observe two Team Leaders because one has additional responsibilities. It was not possible to observe ordinary operators due to the dangerous nature of the work environment. Where available, job descriptions were supplied to the researcher.

3.6.4.3 Data Collation, Documentation and Storage

As in the previous research methodology, in order to maximise the benefit from the evidence Yin's (1994) advice concerning using multiple sources of evidence, creating a case study database and maintaining a chain of evidence has been followed. Primary evidence from the participant observation is in form of transcribed notes, which were then word-processed and tabulated to facilitate analysis. The evidence from Study Two such as documents including job descriptions, extracts from policies, procedures and instructions etc, and handwritten field notes based on observations, meetings and informal interviews provide the additional data required for triangulation and enhancing construct validity. The evidence has been filed in a case study database created for this element of the research. It consists of two sections; one for each organisation to represent the two distinct phases of this research. Each section is subdivided into subsections, one for each of the observed people. In addition, Study Two has a portion dedicated to the additional evidence, which has been cross-referenced where appropriate to other evidence in order to facilitate the chain of evidence.

Finally the chain of evidence is apparent through the iterative analysis phases so that the reader can trace conclusions back through the analysis to the original data, enhancing the reliability and validity of the research.

3.6.5 Data Analysis

This section details the analytic strategy used for the data obtained in both studies. As noted previously within each study the unit of analysis is the individual which forms the case, though the activities performed by the individual are sub units of analysis. It is essential to re-iterate this as the unit of analysis underpins the data analysis phase and techniques selected.

3.6.5.1 Study 1

An analytic induction approach to find the constructs using an iterative procedure to examine "a given set of cases and then refining and modifying those cases on the basis of subsequent ones" (Huberman and Miles 1998) has been adopted. This iterative analysis will be conducted, using the Hierarchical Task Analysis as a guide, focusing on the individuals activities (sub unit of analysis) and by generating codes using a content analysis-led, within case analysis approach examining the individual (as a unit of analysis). Using these methods in this manner will enable an iterative hypotheses-generating process and develop ideas for

further study (Yin 1994). Content analysis will also be used across the two individuals' cases to identify tentative hypotheses for further investigations and analysis. These methodologies align with the "grounded theory" approach (Glaser and Strauss 1967, cited in Huberman and Miles 1998, Yin 1994).

3.6.5.2 Study 2

The data analysis adopted for Study Two is based on that used in Study One with a few modifications to improve the process and reflect the different starting point and the greater variety of data and evidence present within this study. Study Two data analysis will start with a tentative hypothesis based on the definitions and framework derived in study one to support the coding process. This means that more of a template analysis approach (King 2004) will be followed since the codes will have been "defined a priori, but they will be modified and added to as the researcher reads and interprets the texts" (King 2004). In response to the additional data, and knowledge gained from Study One, hierarchical coding will be used to analyse the textual data. Higher-order codes will be used to provide an overview while detailed lower-order codes will enable fine distinctions to be made (King 2004).

Again, individuals activities will be analysed (the sub unit of analysis) using the template codes and other documentation will be reviewed using a content analysis approach using the same themes. Each individual will be analysed (as a unit of analysis) to form the within case analysis. Finally the findings will be compared for cross case analysis.

3.6.6 Publication

Study One has been formally documented and published as a separate case study report (Cooke and Goodyer 2000) and some work, along with other data from the case study database is documented in Chapter 7. Study Two is fully documented in Chapter 7.

3.7 Methodology Review

Although similar methodological approaches have been used for the two phases of this research (Figure 3.2 and 3.3) different data collection and therefore analysis techniques have been selected. The first phase (section 3.5) requires overview information concerning the management of a quality programme, general descriptions of content and perceived linkages. The second phase (section 3.6) requires specific information concerning day-to-day activities in order to understand the precise nature of employees' involvement and engagement in quality activities. Different types of information require different retrieval approaches.

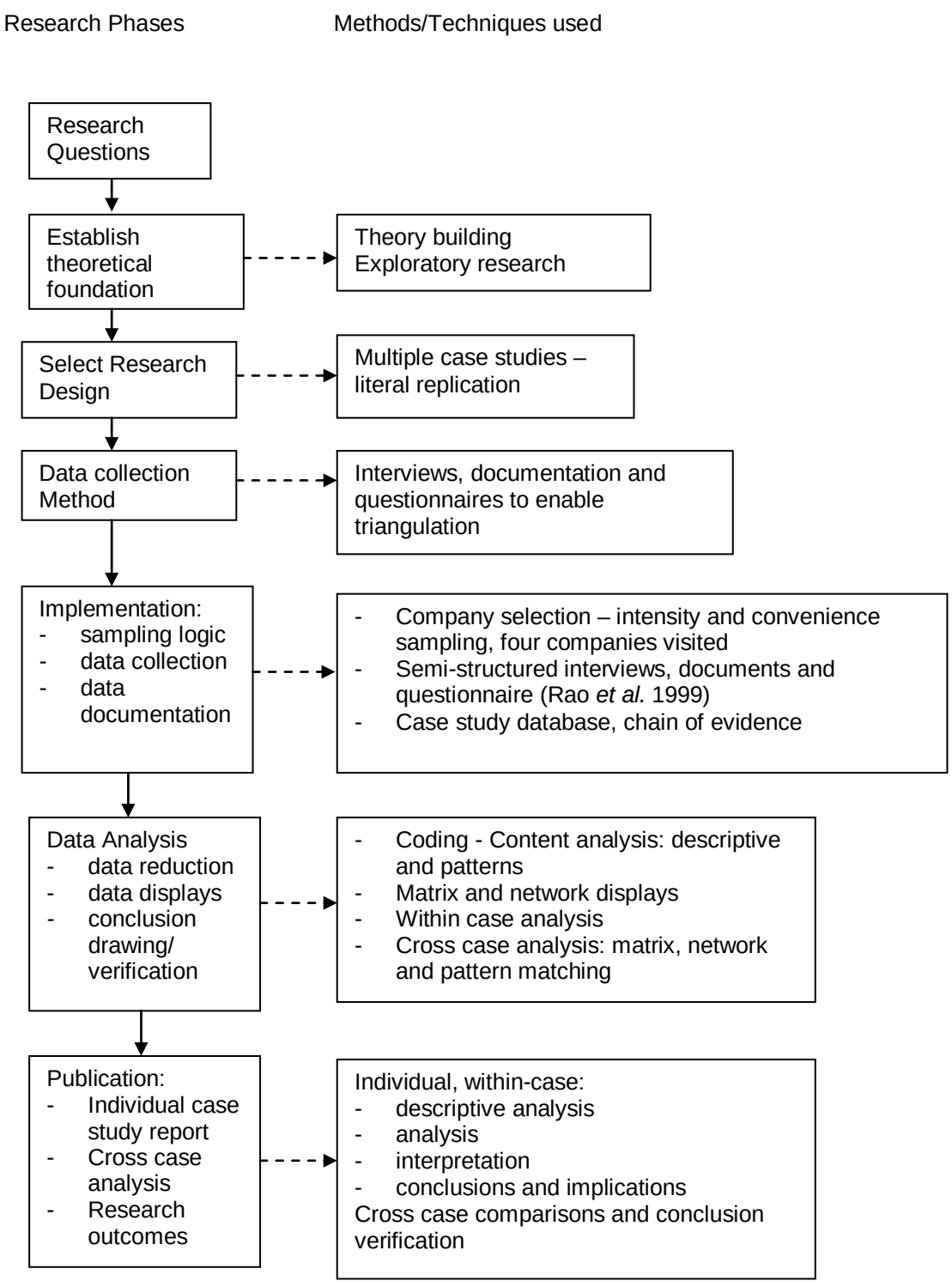


Figure 3.2 Research methodology phases and methods/techniques used: Quality Programme, Practices and Activities

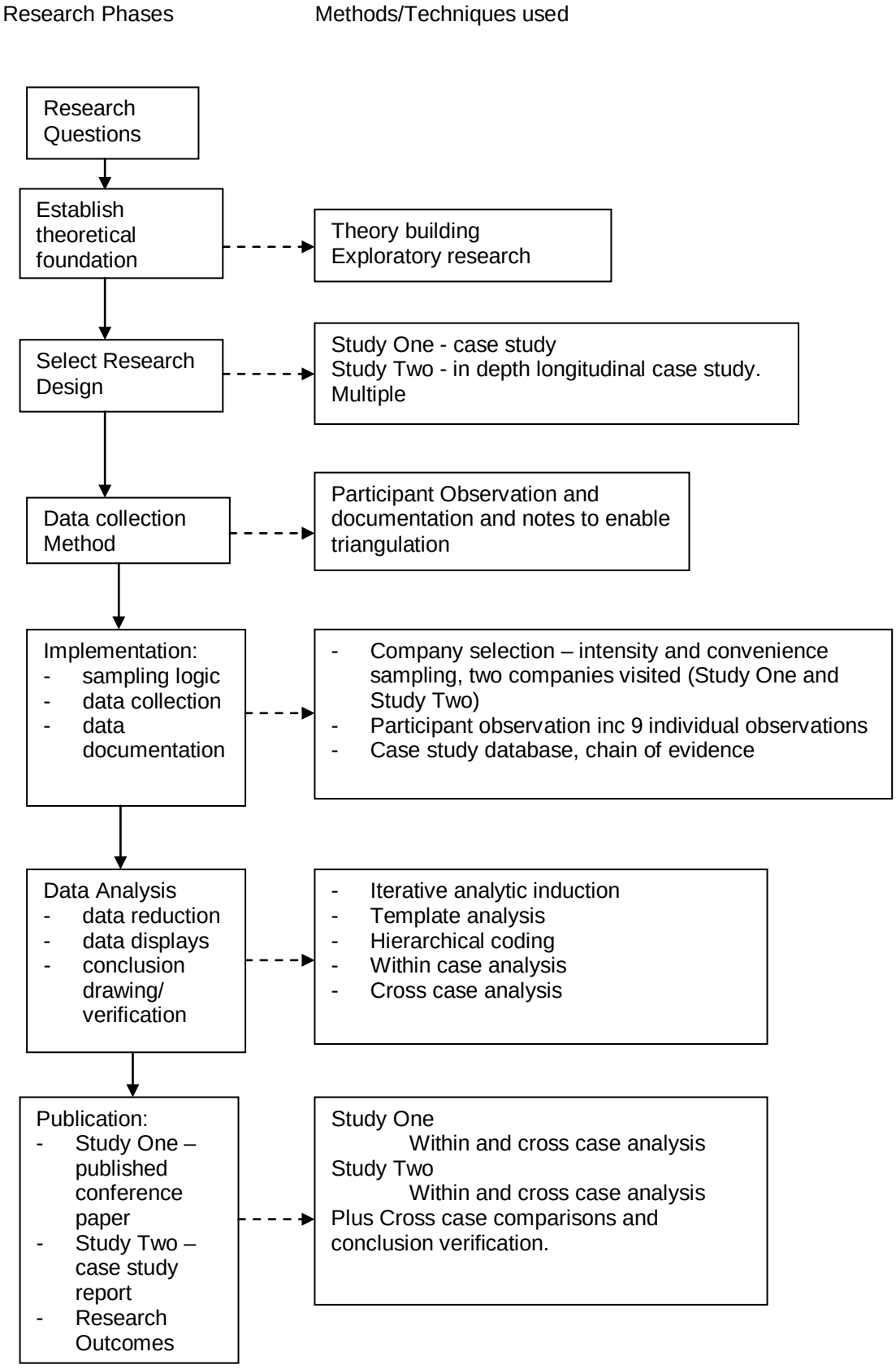


Figure 3.3 Research methodology phases and methods/techniques used: Quality Activities and Employee Involvement

3.8 Research Methodology Chapter Summary

This chapter has detailed the research methodology that has been followed for the two distinct phases of this research.

In order to research company quality programme, quality practices and quality activities the approach can be summarised as exploratory case studies, using a multiple case study approach to achieve literal replication. Triangulation of methods and data has been used in the data collection and data analysis phases, by using interviews, questionnaires and documentation collection methods and matrices and networks to facilitate within case and cross case analysis techniques. The detailed documentation of the research method, along with the techniques used at each stage, has enabled the research to be conducted with regard to appropriate validity and reliability requirements. The research will be presented using within case and cross case reports and has been illustrated in Figure 3.2.

Exploratory case studies have formed the basis for the investigation into quality activities in an operational context in a manufacturing organisation. Participant observation has been used as the primary means of collecting data with an in depth study providing an opportunity for a longitudinal examination enabling multiple data sources to be used for data triangulation. Data analysis has been based on an iterative procedure to generate hypotheses and has called upon content analysis, template analysis and hierarchical coding. The data analysis has been conducted using both within case and cross case analysis. Results from these studies can be found in Chapter 7 and have been summarised in Figure 3.3.

Finally, it is now possible to provide an overview of the structure of this thesis (Figure 3.4) which illustrates the two distinct phases of this research and shows how the two themes will be synthesised in the Discussion chapter.

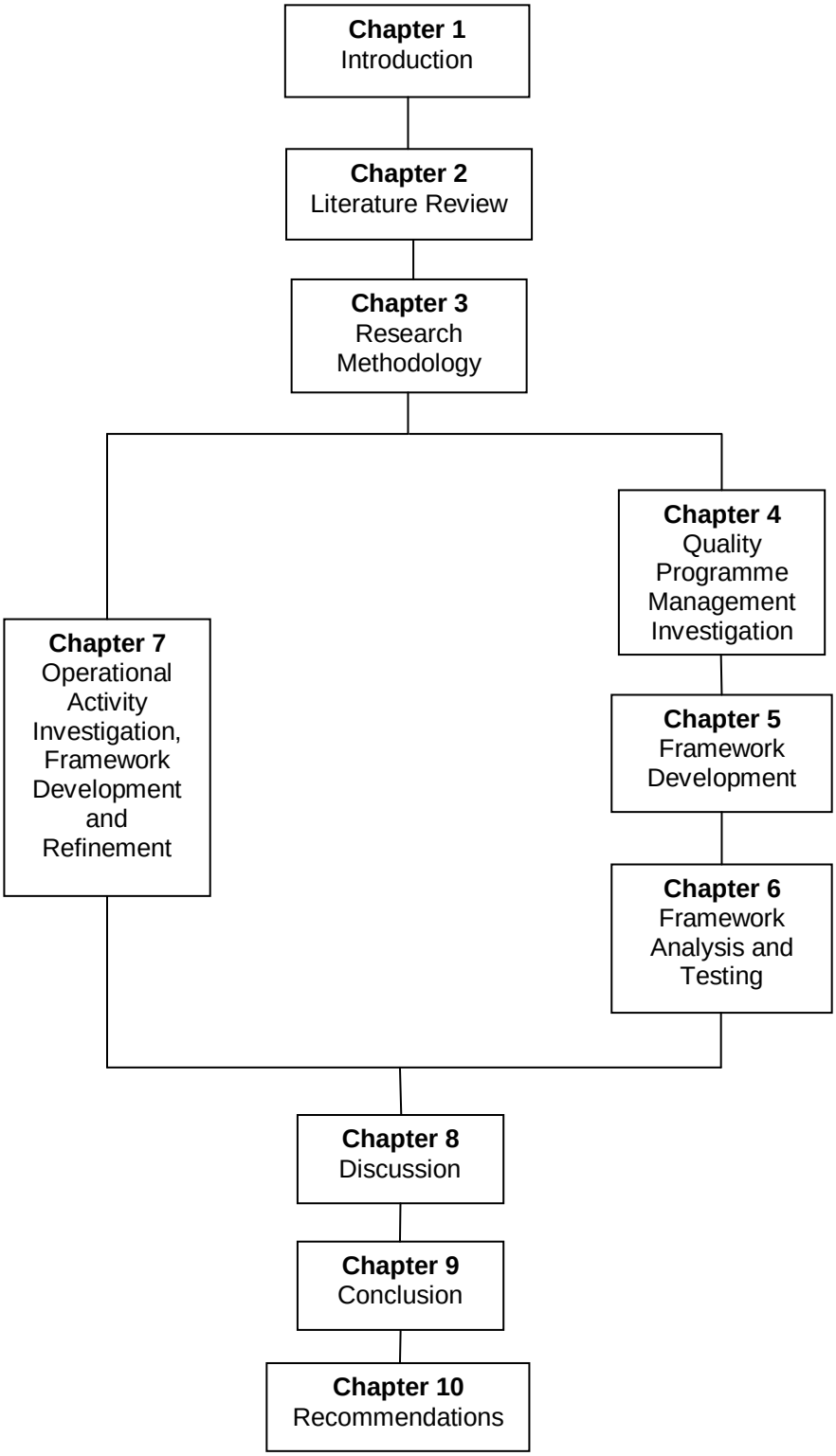


Figure 3.4 Structure of Thesis

(Copy of Figure 1.1)

4.1 Introduction

This chapter presents the findings from the case study investigations into quality programmes, quality practices and quality activities and the subsequent analysis and conclusions, conducted in accordance with the Research Methodology (3.5). The research questions, previously identified in Chapter 3, underpinning the case studies are:

- What are the quality practices and activities that comprise a company quality programme?
- How is the company quality programme operationalised?
- What are the aims and objectives of the quality programme and therefore the quality practices and quality activities?
- Is there a link between the quality programme, quality practices and the actual quality activities deployed? Can the link between quality practices and quality activities be mapped to indicate alignment?

Firstly the results of the within case analysis will be summarised by company, emphasising the outcomes specific to these research questions. Then the cross case analysis will be presented, drawing together and comparing the findings from the individual case studies. A brief discussion concerning pertinent topics emerging from the research methodology is included. This is followed by the creation of a framework based on the case study outcomes.

4.2 Case Study Findings

The descriptive and qualitative nature of the data obtained from the case studies has resulted in the production of a detailed Case Study Report (Cooke 2010) which is supplemented by a case study database which holds the primary data and ensures that there is a chain of evidence. The Case Study Report follows the guidelines in Chapter 3 Research Methodology. The Case Study Report details the within case analysis for each case study company and consists of four discrete stages:

1. Descriptive Analysis. Using the data from the interviews, documentation and questionnaire, and the ensuing content analysis coding results the unit/area of analysis will be described.
2. Analysis. Using data matrices and network diagrams as necessary this section compares and contrasts the different sources of data, particularly that from the different respondents.
3. Interpretations. The results presented are reviewed in order to establish their meaning and justify the subsequent interpretations.

4. Conclusions and Implications. The final stage brings together the outcomes for the company to form conclusions and implications arising from the research so far. When all research areas have been explored, these outcomes will be assembled into a set of final conclusions and implications for the company.

These four stages have been followed to produce a detailed examination and analysis for each of the four research areas (unit of analysis). These research areas are based on the questions identified previously (section 4.1).

1. Quality Programme: a description including its development over time, its current structure and aims and objectives.
2. Quality Practices: the literature based strategic quality practices will be examined, particularly within the context of the quality programme.
3. Quality Activities: the identification and documentation of which quality activities are used and why, along with changes in activity selection and adoption.
4. Link: investigation into the acknowledgement and existence of a link between Quality Programme, quality practices and quality activities and whether a link could/should be mapped and would be beneficial.

This analysis is primarily qualitative and descriptive in nature, and as such was considered too detailed for the main body of this thesis and therefore a summary of the findings at each company for each of the research questions is provided within this chapter.

An Industrial Case Study Report was produced and issued to the companies that participated in the research. This report (Appendix A4) provides a brief, industry orientated overview of the purpose of the research, the study, the findings and conclusions.

4.3 Within Case Analysis Summary

This section provides an overview of each case study company and the key conclusions emerging from the within case analysis, based on the Case Study Report (Cooke 2010) details, for each of the four research areas are presented.

4.3.1 Company A

At Company A, a large automotive manufacturer and subsidiary of a world wide automotive conglomerate, the Company Quality Director and Quality Department Superintendent were interviewed (on separate occasions) and provided documentation and completed a questionnaire as part of the research investigation. Both individuals approached the interviews with significantly different attitudes and this has had an impact on some of the results. The

Company Quality Director reduced the interview time at short notice and restricted the conversation, openly refusing to take questions and ignoring the majority of the ones that were incorporated into the discussion. In contrast, the Quality Department Superintendent was very helpful, provided a significant amount of information and freely answered questions and explored the concepts under discussion.

Company A's main objective is customer satisfaction, and customer feedback is used to determine action to be taken to make improvements. This information also provides the input to generate performance measures, which are in turn used to drive the quality programme and ultimately the quality activities. Performance measurement and management emerged strongly as a theme from the research investigations as it is a critical component of the quality programme at Company A.

It is noticeable that the company has established objectives separate to the quality programme and sets additional targets to achieve. There is only a tenuous link between some of the objectives and quality programme, and on the whole the two systems run in parallel.

The quality programme at Company A is an all encompassing business wide system which includes quality activities. Quality activities are not the only methods used to achieve customer satisfaction, and other non-quality specific activities are used. Quality activities are integrated into the quality programme in such a way that they have become part of the way the people work. In fact the whole programme is viewed from this perspective. These reasons support the "way of working" theme that emerged from the research.

At Company A the phrase "quality practice" is not used, despite the phrase, its meaning and examples being discussed at the start of the interview. Similarly none of the names of quality practices were used. Consequently, the link between quality practices, quality activities and the quality programme could not be identified. With regard to the existence of specific strategic quality practices (as identified by Rao *et al.* 1999), some of these emerged from the content analysis coding and in conjunction with the results of the questionnaire analysis it can be concluded that top management support, strategic quality planning and quality information availability are all performed to a high extent and employee training to a moderate extent. However, whilst the interview and documentation support a high focus on the practices of quality information usage and customer orientation, the questionnaire does not support these results. This particularly suggests a mismatch between how the company works and the items contained within the questionnaires' practices, particularly as it would appear these exist to a high extent. The data analysis suggests that employee involvement practices exist to a low extent. The extent to which supplier quality exists cannot be determined due to a data mismatch and general lack of evidence. Quality citizenship and benchmarking are performed according to the questionnaire results, but do not appear in the interview or documentation

analysis, raising the question, are they perceived as quality practices or part of the quality programme at the company? Finally the situation concerning product/process design is unclear and more evidence is required.

In terms of the research question: Is there a link between the quality programme and quality activities, a direct link could not be established. However a link between customer satisfaction, performance measures and quality activities could be mapped. Quality activities are embedded within the quality programme with regard to the 'way of working' theme and are also used separately to address specific problems. Similarly, performance management and measurement is part of the quality programme. Therefore it can be suggested that there is a relationship between the quality programme and quality activities. However, in the network diagram (Figure 4.1), it is not possible to incorporate quality practices since their relationship to the programme and activities is unclear due to them existing to various extents and not being articulated by the company. Both interviewees are interested in looking at links, particularly in terms of which activities should be done to achieve the best return and maximum improvement in customer satisfaction. Neither interviewee could confirm that they were doing the best/right activities to achieve customer satisfaction or were in a position to determine accurately whether what they were doing should be changed.

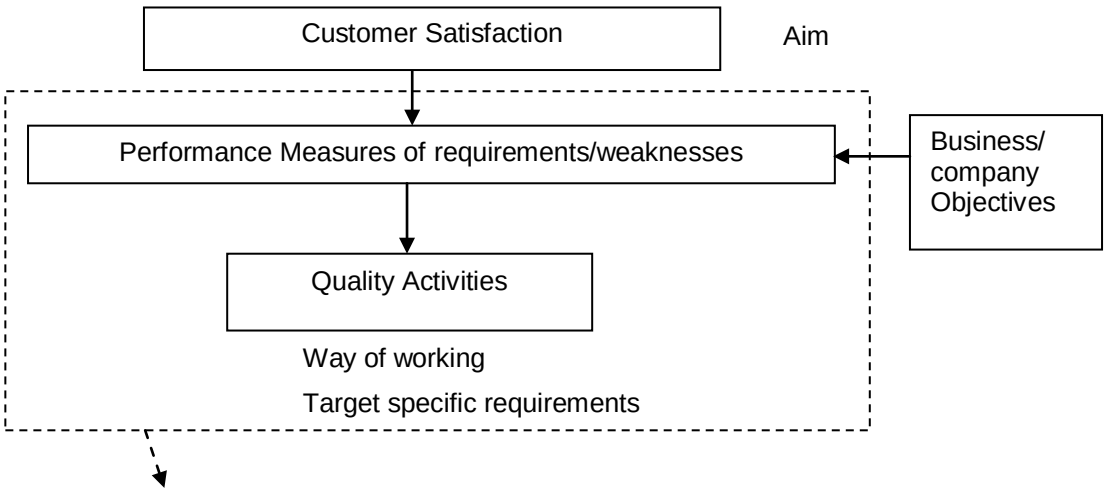


Figure 4.1: Company A Network Diagram.

To summarise, the downward links from customer satisfaction, to the quality programme (which consists of performance management and measurement and quality activities) can be identified. However there is no upward evaluation or confirmation that the activities are having the desired effects. Finally, the respondent attitudes to and interaction with the researcher affected the quantity and type of data collected and in particular the fact that questions would not be answered by the Company Quality Director meant that issues could not be explored

further or clarified. Agreement by a company to take part in research does not guarantee their commitment or co-operation in the interview.

4.3.2 Company B

Company B is a Tier 1 supplier to the automotive industry and supplier of components and assemblies to a selection of the large OEM's. Interviews were held with the Quality Director and a manufacturing – based Quality Engineer. The company did not have a Quality Manager. The Quality Director was willing to spend time with the researcher, discussed the questions openly and provided articulate answers to the topics under investigation. The Quality Engineer had recently been promoted from the shop floor even though he had been performing the role for four years. He struggled to answer some of the questions, with some answers not matching the questions and the interview was frequently interrupted even though it only lasted for one hour.

The research and analysis concluded that Company B does not currently have a formal company wide quality programme and the responsibility for quality rests with the quality department. Therefore the aims and objectives concerning the quality programme and quality activities lacked depth and quality focus and were described as: getting control; customer satisfaction; and cost reduction. Whilst a formal documented system exists for translating company objectives into departmental objectives, the aforementioned ones were not included. The evidence available suggests that the company's approach to quality lacks maturity and aligns with the reactive (fire-fighting) approach to customer satisfaction that is being used.

At Company B neither respondent used the phrase quality practice even though it was defined and examples given at the outset of the interview. The analysis results found that the different data sources presented a consistent perspective concerning the existence of the quality practices. Only top management support and strategic quality planning exist to a high extent. The moderate degree of existence for quality information availability, quality information usage and customer orientation appear to reflect the fire fighting theme, reacting to problems. In addition this reactive approach to problems may be due to a lack of formal programme which would normally include an improvement identification mechanism. The practices of employee training, employee involvement, product / process design and supplier quality which exist to a low extent support the finding that quality is the responsibility of the quality department. This is a possible consequence of Company B not having a formal quality programme.

With regard to quality activities, very few tools and techniques are used, and their deployment is instigated as a consequence of customer issues. There is not a pro-active programme in place to focus the use of tools on improvement issues, despite the Quality Directors' vision

concerning their application and the need to train Quality Engineers in a tool set. The ad-hoc and reactive use of a limited set of quality activities aligns with the lack of existence of a quality programme and the reactive approach to quality issues.

The information on the existence of quality practices and deployment of quality activities at Company B suggests an immature approach to quality management and more work is needed to formalise and introduce a company-wide programme. The current ad-hoc use of activities prevents linkages being examined. As can be seen from the network diagram (Figure 4.2) there are no real linkages between the quality programme, aims and objectives, quality practices or quality activities. Only when the Company has a mature and developed approach to managing quality can such linkages be investigated. At this point, a tool to map linkages cannot be used to determine the effectiveness of the quality activities since only a limited set are being used.

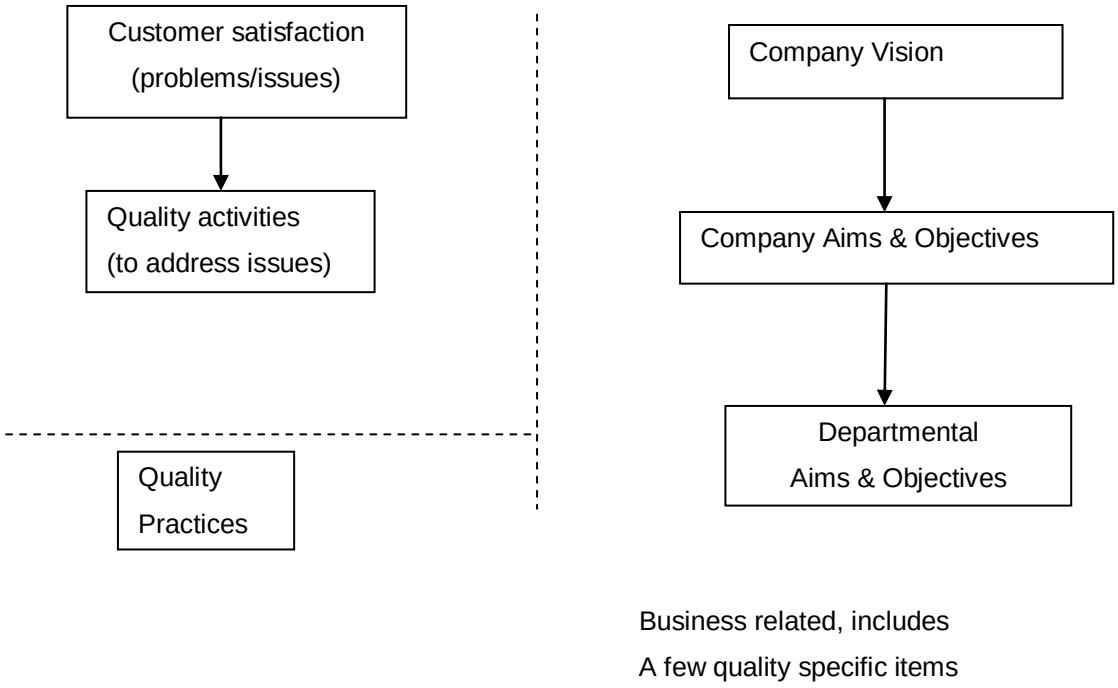


Figure 4.2: Company B network diagram

4.3.3 Company C

Company C is a subsidiary of a worldwide aerospace group, and first tier supplier to the Aerospace industry. Interviews were held with the Vice President with responsibility for quality, at the UK Head Office and with a Site Quality Manager at a regional manufacturing facility. Both interviewees discussed the interview questions openly and provided a significant amount of documentation, where available, to support their answers and provide supplementary detail.

The quality programme at Company C is called Six Sigma which has evolved from the Total Quality Programme and more recently the Advanced Total Quality Programme. The aim of the quality programme is stakeholder satisfaction and this is managed through the setting of key objectives and performance targets which are translated into manufacturing action plans. Through this mechanism the quality programme is embedded into the way of working within the manufacturing area. In addition, the Six Sigma programme is designed to enable business improvements and work alongside other management practices, resulting in projects which run alongside the day-to-day elements of the quality programme. Six Sigma Black Belts (and Green Belts) are given projects to improve the business performance, which are not necessarily quality orientated. The projects are determined based upon the objectives to achieve given performance targets, and the projects are monitored from a financial perspective. Six Sigma projects are used along with other management practices to achieve business improvements. In addition, the Six Sigma programme (and the Total Quality and Advanced Total Quality Programme before that) have promoted the training of employees in quality tools and techniques.

The phrase quality practice is not used at Company C. Whilst describing the quality programme and quality activities, the respondents focused on what was actually being done and did not refer to the names of quality practices. Analysis and interpretation of the various data sources revealed that the practices of strategic quality planning, quality information availability and employee training exist to a high extent and the practices of top management support, product/process design and customer orientation exist to a moderate degree. Supplier quality, citizenship and benchmarking exist to a low extent. Whilst there was agreement on the extent to which these practices existed, the situation concerning quality information usage and employee involvement required further consideration. The significant focus on performance management and measurement which emerged from the analysis suggests that the questionnaire items do not reflect how the quality information usage practice is fulfilled at Company C. In order to manage and measure performance it is necessary to have and use quality information. Since the performance management and measurement at Company C is conducted with a business-wide remit rather than a quality specific focus this could explain why the questionnaire items do not reflect the practices at Company C and indeed explain the mismatch in the findings when all data is analysed. Therefore the performance focus and the conclusion that quality information availability is evident to a high extent, add support to this argument. However, the situation concerning employee involvement is still unclear and would need further investigation. The Case Study Report (Cooke 2010) details a number of reasons why the different data sources have not provided a consistent view for these practices, but can be summarised as:

- A “pet” subject continually being referred to by the interviewee.
- Different jobs and responsibilities of interviewees’ influencing their opinions and perceptions of what happens.
- Questionnaire items not reflecting how the practices are actually deployed.
- Documentation tended to compliment interview topics and interviewees’ areas of interest which led to reduced data collection in some of the areas.

Quality activities, emerged strongly from the analysis from both interviewees, and it can be concluded that they are the main component of the quality programme, particularly the 'hard' tools and techniques. Each manufacturing cell has an action plan, to achieve the performance targets, which comprises a number of activities, some of which are quality tools and techniques. In addition, each cell has a quality system which specifies the day-to-day activities to ensure performance monitoring and improvement. As a result the quality activities, particularly the ‘hard’ tools and techniques are embedded into the way of working at an operational level in the organisation. However further research at Company C concerning which tools are selected and deployed and why and also the application of the 'soft' quality activities is required.

With regard to the research question concerning the link between the quality programme, quality practices and quality activities, it is difficult to include with any confidence quality practices in the link between the quality programme and activities. A direct link from the company's aim, to the objectives, to the performance measures to both the six sigma project activities and the embedded way of working quality activities could be clearly identified. These relationships are shown in the network diagram (Figure 4.3).

Therefore, the respondents could identify why certain activities were being performed and in particular link them to performance measures and targets, however they could not confirm whether they were the best activities or having the desired effect. It should be noted that the aims, objectives and performance targets, along with the six sigma projects and activities within the cell were not solely quality orientated but were in fact related to other business wide aspects.

At Company C a tool that enables the quality activities to be mapped against the programme and performance targets would be beneficial to the management of the organisation. In addition, a tool which provides upward feedback from the activities to the corporate aims and objectives, in order to provide information concerning the correct selection and deployment and that required results are being achieved would be useful.

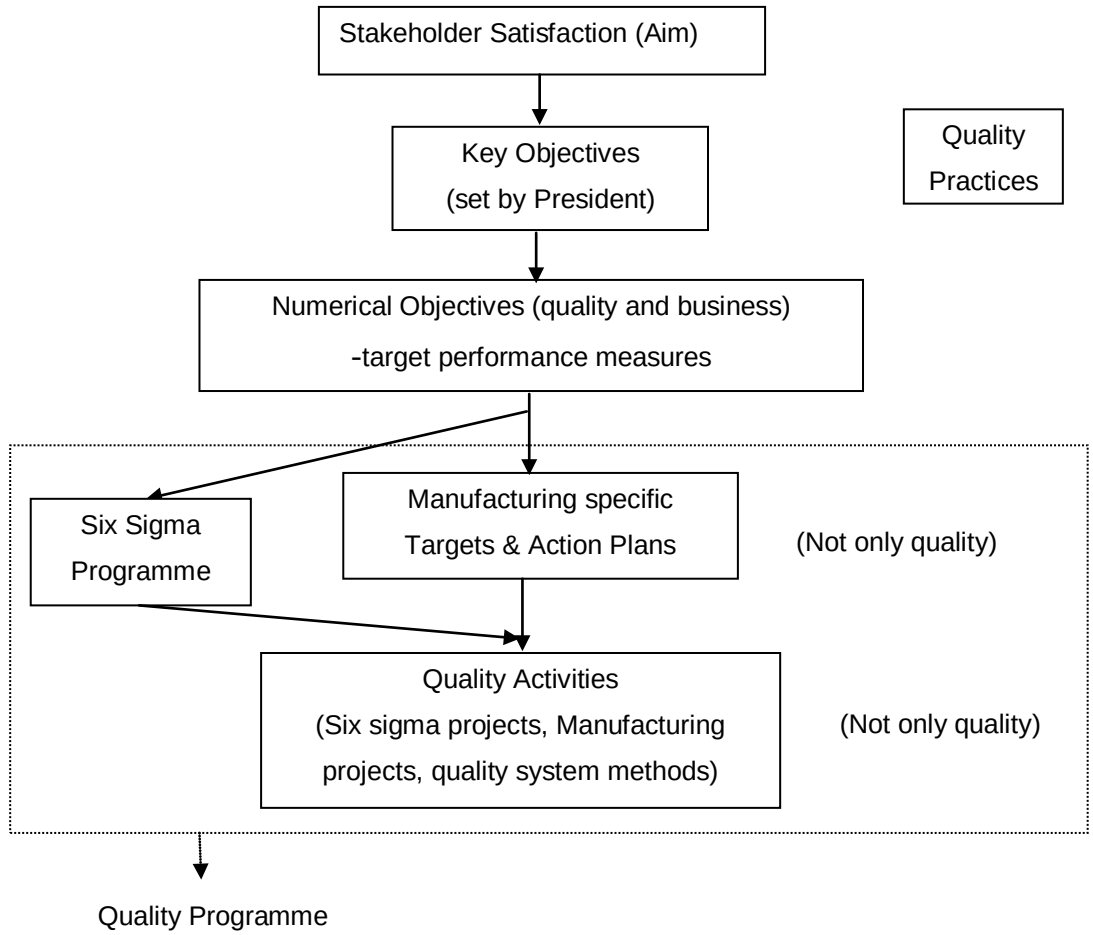


Figure 4.3 Company C Network Diagram

4.3.4 Company D

Company D is a domestic white goods manufacturer with several UK plants, and is part owned by a multi-national Italian organisation. The company was selected for its reputation for quality management and application of quality activities. However access was very difficult to obtain, with only one interview being granted, with the HR Director who had formerly been a Master Black Belt and Quality Professional within the organisation. It should be noted that during the interview the interviewee was reluctant to provide detailed fact-based answers and refused to provide supporting documentation of this nature.

Company D has had a number of formal ongoing and evolving quality programmes. The current programme, Six Sigma has been in place a number of years, and it is used to achieve customer and quality related aims, though the company performance objectives are the main driver of the quality programme. The performance objectives and associated measures are not solely quality - orientated, although quality objectives and measures have been identified by the organisation to support the quality strategy.

The phrase 'quality practice' is neither used nor identified with at Company D. With regard to the quality practices (identified by Rao *et al.* 1999), it appears only top management support and quality information availability exist to a high extent. Customer orientation and benchmarking exist to a moderate extent. However, strategic quality planning, supplier quality and product / process design exist to a low extent. Conclusions concerning the practices of quality information usage, employee training, employee involvement and quality citizenship could not be determined. A particular contrast in evidence was apparent for the practices of employee training and employee involvement. These were discussed in detail during the interviews yet the questionnaire results were low for these practices. The Case Study Report (Cooke 2010) suggests this may be due either to interviewee bias towards a “pet” subject (HR Manager may tend to emphasise his responsibility) or it could be the questionnaire did not articulate the practices in place at Company D.

Quality Activities are the main component of the quality programme at Company D. Both ‘hard’ and ‘soft’ tools and techniques are emphasised. The 'hard' tools and techniques are used directly within six sigma projects and the 'soft' tools and techniques are used to support and facilitate change. Quality activities are also deployed in order to align with the organisations strategy.

A network diagram has been produced (Figure 4.4) to show the link between the quality programme, quality practices and quality activities.

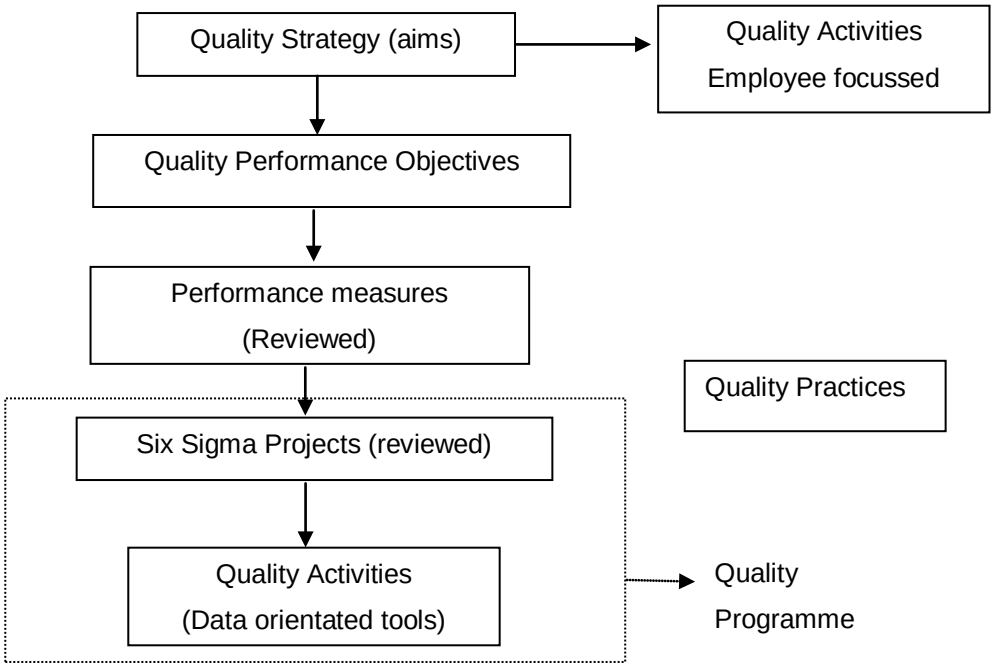


Figure 4.5 Company D Network Diagram

In considering this link it is apparent that the quality practices do not automatically align with the other items and therefore sit separately. However the addition of performance objectives

and measures, as a driver for the six sigma projects and ultimately the quality tools and techniques has been included. It is apparent that Company D does not formally make any downward connections from the strategy to the quality activities since the interviewee felt such a check was not necessary emphasising that meeting the performance objectives was what counted. Also, they do not do any feedback evaluation or confirmation that the activities do contribute to the strategy. However, the company does have intermediate reviews of the six sigma projects and the performance measures to ensure that the performance objectives are being met.

All these conclusions are based upon limited data when compared against the other case study companies: only one interview, one questionnaire and two small documents; and although represent the findings, further research would provide deeper results and enhance the validity.

4.4 Cross Case Analysis

The cross case analysis will focus upon the research questions, adopting a variable oriented strategy in order to find themes that run across cases (Huberman and Miles 1998). The four variables that are considered at this stage of the analysis are the quality programme, the quality practices, the quality activities and the link between the three. This stage of the analysis brings together the findings from the within case analysis for each of the company's in order to establish generalizable conclusions.

In order to facilitate the cross case analysis a meta-matrix (Table 4.1 Case Study Company Summary) was developed in order to summarise and compare findings across the four companies for the research areas of the quality programme, quality practices and quality activities.

4.4.1 Quality Programme

The semi-structured interview questions were developed to ascertain specific information concerning the quality programme, yet the documentation and interview coding analysis results (Tables 4.2, 4.3 and 4.4) indicate that the theme did not emerge particularly strongly, with an overall rank of fifth in each table. Three companies (A, C and D) have a formal programme in existence yet the coded data quantities across all four companies are not significantly different.

Company	A	B	C	D
Quality programme	• Company-wide programme, "Quality Operating System" • Aim - customer satisfaction • Embedded in way of working • Business not solely quality focused • Includes performance management and measurement	• No formal programme • Quality is responsibility of quality dept. • Aim – control, customer satisfaction and cost reductions	• Company-wide programme, "6 Sigma" • Aim – stakeholder satisfaction including customer satisfaction • Embedded in way of working • Performance targets focused • Business improvement not only quality improvement included	• Company-wide programme, "6 Sigma" • Performance targets • Not only quality focused – business focus
Quality Practices	• Phrase not used • Practice names not referred to • Could not map to programme or activities • No consent on practices of product/ process design, supplier quality, Quality citizenship or bench-marking	• Phrase not used • Practice names not referred to • Could not map to programme or activities • No consensus on quality citizenship	• Phrase not used • Practice names not referred to • Could not map to programme or activities • No consensus on quality information usage and employee involvement	• Phrase not used • Practice names not referred to • Could not map to programme or activities • No consensus on quality information usage, employee training, employee involvement and quality citizenship
Quality Activities	• Main component of quality programme • Way of working • Focus on performance measures	• No formal system for deployment of activities • Tools used for "firefighting" • No soft tools • Limited hard tools	• Main component of quality programme • Way of working • Focus on performance measure	• Main component of quality programme • Focused application in projects to achieve performance targets

Table 4.1 Case Study Company Summary

The quality programmes provide a structured approach for improving quality, but there is more emphasis on the content, that is what is done (the quality activities) and why (the performance objectives and measure targets), rather than focusing on the actual quality programme. The formal existence of a programme is therefore not significantly reflected in a general data count, but mainly in the textual information. The quality programme provides a 'label' for the activities that are performed, either on a project basis or day-to-day basis.

Companies A, C and D all have a 'framework' which is used to identify the need to deploy the activities. At these companies this framework is based upon performance management and measurement, through setting objectives and performance measure targets. The performance measurement and management theme emerged particularly strongly from the analysis (Tables 4.2, 4.3 and 4.4) with a final combined overall rank of second most popular theme (Table 4.4). At Company A it is integrated into the quality programme whilst at companies C and D it is separate to the quality programme. In all cases the performance measures and the activities focused on more than quality, and incorporated business-wide issues.

**Company Respondent ** Pattern Codes	**AR1**	**AR2**	**BR1**	**BR2**	**CR1**	**CR2**	**DR1**	**Total**	**Rank**
Quality programme	4	1	4	2	3	6	6	26	5
Quality practice	1	2	0	0	1	0	0	4	10
Quality activities	4	11	11	7	9	8	10	60	1
Aims and Objectives	0	7	8	2	1	9	4	31	4
Link	3	10	6	2	5	15	10	51	2
Way of working	3	9	1	0	7	0	3	23	7
General management	2	5	5	1	2	7	2	24	6
Performance management and measurement	1	8	9	1	8	5	9	41	3
Cost/Money	0	1	9	1	0	2	2	15	9
Continuous change	0	1	4	0	4	4	3	16	8
Total Data	18	55	57	16	40	56	49	291	
Company Total	73		73		96		49		

Table 4.2 Interview Pattern Codes: Frequency of occurrence by interviewee and overall rank

**Company Respondent ** Pattern Codes	**AR1**	**AR2**	**BR1**	**BR2**	**CR1**	**CR2**	**DR1**	**Total**	**Rank**
Quality programme	1	1	0	0	0	0	0	2	5
Quality practice	0	1	0	0	0	0	0	1	6
Quality activities	5	2	1	1	4	1	1	15	1
Aims and Objectives	0	3	1	0	0	1	1	6	3
Link	0	0	0	0	0	1	0	1	6
Way of working	1	0	0	0	0	0	0	1	6
General management	0	1	0	0	1	1	0	3	4
Performance management and measurement	0	3	1	0	7	1	0	12	2
Cost/Money	0	0	0	0	0	0	0	0	9
Continuous change	0	0	0	0	0	0	0	0	9
Total Data	7	11	3	1	12	5	2		
Company Total	18		4		17		2		

Table 4.3: Documentation Pattern Codes: Frequency of occurrence and overall rank

Key: AR1, AR2: Company A respondent 1, Company A respondent 2.
BR1, BR2: Company B respondent 1, Company B respondent 2.
CR1, CR2: Company C respondent 1, Company C respondent 2.
DR1, DR2: Company D respondent 1, Company D respondent 2.

Company Pattern Codes	**A**	**B**	**C**	**D**	**Total**	**Rank**
Quality programme	7	6	9	6	28	5
Quality practice	4	0	1	0	5	10
Quality activities	22	20	22	11	75	1
Aims and Objectives	10	11	11	5	37	4
Link	13	8	21	10	52	3
Way of working	13	1	7	3	24	7
General management	8	6	11	2	27	6
Performance management and measurement	12	11	21	9	53	2
Cost/Money	1	10	2	2	15	9
Continuous change	1	4	8	3	16	8

Table 4.4: Combined Interview and Documentation Data Occurrence totals for each code, by company.

The case study companies discussed the aims and objectives of the quality programme and this code appeared with an overall final rank of fourth (Table 4.4) based on number of occurrences. Companies A, B and C identify customer satisfaction as their overall aim (Table 4.1). In investigating the aims and objectives of the quality programme it became apparent that these were focused on business issues, associated with customer satisfaction, and closely linked to the performance management and measurement theme. This in turn led to the emergence of the general management theme, as the quality programme fitted and worked alongside other management approaches used at the organisation.

At Companies A and C the quality programme was designed to be part of the operational day to day activities and is embedded in the way of working. At Company D, the limited data showed initial indications that the way of working theme applied to the application of quality activities. It is this way of working theme that identifies a clear difference between the companies with and without a formal quality programme. Across all the other pattern themes that emerged from the research the results of the analysis did not particularly vary, with frequency of occurrence of the themes being very similar despite this fundamental difference. However, the way of working theme was the exception to this trend with a clear difference between Company B and the others (Table 4.4).

It became apparent that at Companies A, C and D the quality programmes evolved over a period of time and even at Company B the approach to quality management was continuously changing albeit in a reactionary mode, resulting in the continuous change theme emerging from the research. It is apparent that it is necessary for quality programmes to be dynamic and be able to evolve to meet the changing business needs.

4.4.2 Quality Practices

The within case analysis concluded that the phrase quality practice is not used at any of the case study companies. In addition the quality practice names (specified by Rao *et al.* 1999) are not used. The case study textual information was analysed for themes which reflected the quality practices articulated by Rao *et al.* (1999) rather than use of the practice names per se but even this found significantly limited use and resulted in a clear last place rank for this data (Table 4.2). Consequently, the relationship of the practices to the quality programme (for companies A, C and D) and to the quality activities (at all companies) cannot be determined.

The extent to which a quality practice exists at a company was determined as far as possible using the three data sources (interview, documentation and questionnaire) and detailed along with a justification in the within case analysis in the Case Study Report (Cooke 2010). The results for each company can now be compared (Table 4.5).

Company Classifying Codes	A	B	C	D
Top management support	H	H	M	H
Strategic quality planning	H	H	H	L
Quality information availability	H	M	H	H
Quality information usage	H	M	NK	NK
Employee training	M	L	H	NK
Employee involvement	L	L	NK	NK
Product/process design	NK	L	M	L
Supplier quality	NK	L	L	L
Customer orientation	H	M	M	M
Quality citizenship	NK	NK	L	NK
Benchmarking	NK	L	L	M

Key:
H= exists to high extent
M= exists to moderate extent
L= exists to a low extent
NK = existence not known

Table 4.5: Extent to which quality practices exist based upon all evidence sources

This suggests that:

- Top management support, strategic quality planning and quality information availability exist to a high extent at three of the four companies. Noticeably Company B results are very similar to those of Companies A, C and D.
- Customer orientation exists to a moderate extent at three companies (B, C and D) and high extent at Company A.
- Supplier quality exists to a low extent at three companies (B, C and D).
- There is not a consensus concerning the extent to which the other practices exist at the companies
- Quality information usage and employee involvement both have two ‘not known’. It is noticeable that for both Companies C and D, where this scenario occurred, the questionnaire ranking is low yet the interview and documentation data source rankings are relatively high suggesting the practices exist.
- Seven of the practices have at least one ‘not known’ allocated against them
- Quality citizenship has three ‘not known’, appearing just once in all the company interview and documentation sources (resulting in a rank of eleventh) yet it tended to score highly in the questionnaire results, with a final rank of fourth. This suggests that quality citizenship is not considered part of a quality programme.

The investigation into quality practices and their existence has identified some issues within the scope of this research which in turn has led to questions in terms of wider quality management research.

Although Company B does not have a formal quality programme and has a reactive approach to quality improvement, when comparing the existence of quality practices with those of other organisations there is not a significant difference in the practice(s) existence that would lead the researcher to this conclusion. Relying on the questionnaire alone would not have generated this finding.

There are many not knowns (NK) when all data sources have been used to form an opinion concerning the existence of quality practices. These have arisen due to a mismatch in data evidence pointing to differing conclusions.

Therefore how useful are this type of questionnaire in establishing the true existence of quality practices at an organisation? Do they accurately articulate how a quality practice is deployed in a way that an organisation understands or relates to? Are quality practices (via the outcomes of questionnaires) a useful way for an organisation to organise their approach to quality management? As standalone questionnaires they apparently provide useful information which researchers have concluded to be reliable and valid. Yet when the questionnaire results are compared to rich contextual data the usefulness of the questionnaires appears limited. Therefore there are a number of opportunities for further investigations.

4.4.3 Quality Activities

Despite the actual difference in tools and techniques identified by the companies and the differences in deployment within the company quality programmes, at an overview level the findings are very similar. At the companies with a formal quality programme (A, C and D) it is noticeable that the quality activities are the main component of the quality programme and all the companies have a formal project identification system to initiate the deployment of the activities. This system is based upon performance measures and targets. In addition, at Company A and C the quality activities are an inherent part of the way of working for employees embedded in the day-to-day operations of the company. Also, as can be seen (Table 4.6), all companies referred to a similar number of tools and the number of ‘hard’ tools was substantially greater than the number of ‘soft’ tools mentioned. A difference in the specific tools applied was anticipated/expected as a company would select the ones that suited their product/process and employee skills. However, how a company selected the most appropriate tool/techniques or evaluated its’ effectiveness could not be established.

Company Quality Activity Type	A	B	C	D
'Hard' Quality tools/techniques	12	9	7	9
'Soft' Quality tools/techniques	2	1	2	3
Total	14	10	9	12

Table 4.6: Quality Activities Totals mentioned by each company, by quantity and type.

4.4.4 The link between the quality programme, practices and activities.

If the research question is considered, it can be seen that for the companies that have a formal quality programme a link from the company aims to the quality activities can be mapped in a network diagram. In each company this link is through performance management and measurement.

None of the companies could comment upon the effectiveness of the quality activities (tools and techniques) that they used or whether they were using the most appropriate, although Companies A, C and D could confirm whether they were achieving their performance targets. The actual process for the selection of the quality activities to use is unclear and appears to be given little or no consideration. None of the companies perform an upward check of the contribution that the activities make. It is noticeable that Companies A, B and C felt a tool would be beneficial yet Company D felt it was covered, but a tool would help SME's.

Quality practices did not fit into the link or network diagram because although some exist to varying extents at the companies, as they were not referred to directly, their role in the network diagrams is vague and only a tenuous suggested link exists at best. A summary of the findings concerning the existence and need for links are shown in Table 4.7.

Using the individual network diagrams from each of the case study companies which have a quality programme, a generic network diagram (Figure 4.6) has been produced which could be applied to the three companies. The diagram shows that there is a downward link from the companies' aim to quality activities. The quality programme differs slightly at the companies and though existing formally, when it comes to displaying it in network diagram, it is apparent that the name is just a label that brings together the same elements across the companies. Although the actual detail in the quality programme differs between the companies the generic framework appears to be the same. The quality programme at Company A includes the performance and quality activity boxes. At Company C and D the quality programme is specifically the activities, both types for Company C, and just the project based activities at Company D.

Company	Link Y/N?	Comments
A	Yes	• Customer satisfaction – performance management and measurement – quality activities • Downward link as above, no upward evaluation or audit • No tool to check for alignment • Interested in best return for efforts
B	No	• No formal programme, no recognition of quality practices, ad-hoc use of quality activities = no 'map' of link • Presented map is fragmented due to above • Interested in tool, would find one useful (when structure in place)
C	Yes	• Satisfaction – objectives – performance measures – module targets and plans – six sigma programme and activities • Tool beneficial to check for alignment and provide feedback • Link less clear at an operational level
D	Yes	• Quality strategy – performance objectives – performance measures – 6 sigma projects – quality activities • Tool considered not required at company D, but useful for SME's • Only projects and performance measures reviewed • No upward audit/evaluation

Table 4.7 Link between quality programme, practices and activities

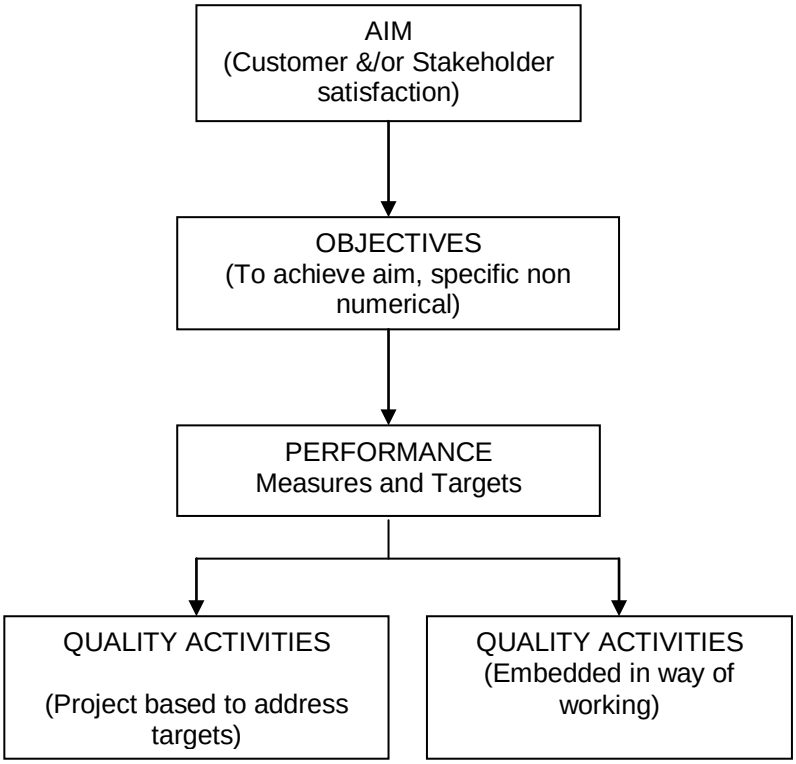


Figure 4.6 Generic Network Diagram.

It should be noted that Quality Practices have been omitted as the generic network diagram is based upon the facts that the evidence provided. In none of the cases could the relationship of the practices to the programme or activities be determined with any confidence. In addition the existence of different practices to differing extents would mean that the diagram would have to be unique to each company as each practice would need to be considered on an individual basis. But even doing this the relationship of the practices to quality activities in the diagram still cannot be specified.

4.5 Cross Case Analysis Conclusions

The cross-case analysis has generated the following conclusions:

- A formal quality programme provides a 'label' to group quality activities by and exists as part of a 'framework' that provides a system for deploying the activities to target specific performance measures. The aims of the quality programmes tend to be "satisfaction" orientated, and customer satisfaction is a key driver. The objectives of the quality programmes are expressed numerically and provide quantifiable targets. Performance management and measurement is critical to the success of the programme and the main driver of the quality activities. The investigation found that the component parts of the quality programme differ between companies along with the programme name, key activities and management approach. The network diagrams revealed that certain key phases are necessary: articulate aims, quantify numerical performance objectives, and allocate specific activities/project for each objective. In addition, the programme encompasses more than quality activities and is used to achieve company-wide improvements.
- The phrase 'quality practice' is not used and the academically generated practice names (typically articulated on questionnaires) are also not referred to or used at any of the case study companies. The extent of existence of the practices varies across the companies and this does not reflect the existence of a formal quality programme or the use of quality activities. Further investigation into how well the questionnaire items articulate the quality practices is required in a qualitative research setting due to the mismatch in evidence from the different data sources. Within company comparisons concerning the strength of the existence of practices was beneficial but cross-company comparisons was not possible at a detailed practice level.
- Quality activities (tools and techniques) are the main component of a formal quality programme. They can be embedded in the way of working at the company and also used to address certain performance targets. The specific tools and techniques used appear to vary across the companies. There does not seem to be a formal method (apart from training) of selecting the most suitable tools and techniques to use.

- A network diagram has been developed which links the company aim to objectives, to performance measures and to quality activities. It is noticeable that the quality programme appears indirectly as a consequence of this link and that the quality practices do not appear at all. The case study companies did not perform any upward evaluation of the effectiveness of the quality activities or whether they were the most suitable for use.

4.6 Effect of Research Methodology on Analysis

The within case and cross case analysis outcomes are determined to an extent by the research methods deployed to obtain the raw data. Therefore a reflection on the approach will review the detailed data collected and observations regarding the company selection, respondent selection, data sources and other issues concerning the research methods deployed.

4.6.1 Company Selection

The case study companies were selected in order to demonstrate literal replication, that is, the companies should exhibit the same characteristics and therefore the findings should be comparable across all cases. Although the companies selected were based upon recommendations of exemplar practice it can be seen from the conclusions concerning Company B, that upon analysis it did not meet the criterion, specifically it does not have a formal company-wide quality programme. If the data obtained from Company B is examined, (Tables 4.2, 4.3, 4.4, 4.5 and 4.6) the data collected tends to reflect the profile of that collected from the other companies. In terms of the interview data, the data is spread through the classifying codes in a similar pattern to the other company data, although there is less of it (possibly indicative of the lack of quality programme). However, the pattern code data analysis is very similar to that obtained from the other companies. Although little documentation was provided, again the analysis results have a similar pattern to that achieved through the other companies. The lack of a formal programme only becomes apparent when the textual narrative data is examined, and the three data sources triangulated. The lack of awareness and levels of existence of quality practices at Company B was also similar to the other case study companies. Table 4.5 shows that five practices exist to a low extent compared to the Company C (the next worst) with only three practices existing to a low extent. Another indicator of the situation at Company B is only one ‘soft’ quality activity being referred to (Table 4.6). As a consequence the research question could not be fully investigated at Company B and only a fragmented network diagram could be established.

The inclusion of Company B in the analysis, with its lack of formal quality programme although by accident rather than design, has led to the following observations about the research methodology:

- A literal replication approach was the correct one to select in order to enable validation of findings.
- The selection of exemplar companies was the correct approach, as the question cannot be answered by researching companies that do not have a quality programme.
- The use of three separate data sources and a data triangulation approach in the analysis has been confirmed as essential in order to establish the real picture of events at the case study companies.

4.6.2 Respondent Selection

The purpose of interviewing two people at each company was to provide extra information and greater depth to the findings and support outcomes and conclusions generated through the research. It was decided to talk to a senior executive with responsibility for the programme as this would provide a company-wide perspective and overview of the programme and interview an individual with responsibility for operationalising the quality programme in a manufacturing department in order to find out details concerning activities. In addition the different jobs would provide different perspectives. This was achieved in companies A, B and C. In companies A and C the people interviewed supplied complementary evidence which enabled reliable conclusion to be formed about most aspects of the research questions. At both companies the people were the senior executive responsible for quality and a manager responsible for using the programme to achieve the performance targets. At Company B, whilst the Quality Director and a Quality Engineer were interviewed, it was noticeable that the quality engineer was not a manager and had quality responsibilities limited to certain products. This affected his responses and as can be seen from Tables 4.2 and 4.3, BR2 provided significantly less data than the other people interviewed. One reason was his lack of ability to answer strategic type questions and relate what he did to the questions. However, another reason was the lack of quality programme at Company B meant he could not discuss what did not exist. On a positive note, the findings from the interview with BR2 did support the analysis of the information obtained from BR1.

Finally at Company D it was only possible to meet with a HR Manager. Whilst this manager was very knowledgeable about the programme in a general sense, strategically in terms of aims and objectives and operationally with regard to specific activities his answers lacked depth and detail. This has had two main effects on the research. Firstly, one primary data source (although three evidence sources were used) meant that there was no way to validate the information received. However if the profile of the information is compared to that received from the other companies (Tables 4.2, 4.3 and 4.4) the information is not significantly different, apart from the emphasis on employee training.

The selection of respondents at the companies has had the following affects on the research findings:

- The use of two (quality-role-oriented) respondents at companies A, B and C has provided a reliable perspective of the situation and validates any conclusions drawn.
- The use of one respondent in a non-quality specific role has resulted in less reliable findings from Company D. Further research using a person in a quality role would enhance the reliability and validity of the conclusions for Company D.
- Together these findings justify the research methodology approach selected.

4.6.3 Data Sources

Although access to the companies had been obtained, access to pertinent information was difficult. During the interviews with the quality (and HR) executives there was a tendency for them to discuss what they thought you wanted to know rather than answer the questions. AR1 was particularly open about which questions he would not answer and would not discuss topics he did not want to. Also, these people were less comfortable providing documentary evidence and despite assurances of confidentiality did not provide requested documentation. The managers at Companies A and C were more obliging in the interviews and discussed topics readily. Similarly they were happy to provide documentation for analysis subject to confidentiality being maintained. The quality engineer at Company B (BR2) simply did not have access to any amount of information to support the interview. Although all the respondents agreed to complete the questionnaire after the interview, respondents AR1, AR2, BR1 and DR1 all required a significant amount of follow-up in order to get responses.
A comparison of the analysis results from the different data sources and different respondents (Tables 4.2 and 4.3) reveals that, despite these difficulties with the data sources, the profile of results for the classifying and pattern codes is very similar across the different companies.

During data triangulation in the analysis phase, a mismatch between the three data sources became apparent for some of the quality practices especially at companies A and C. It is noticeable that the mismatch in evidence was for different quality practices at the different companies. The possible reasons for these mismatches have been detailed in the within case analysis (Case Study Report, Cooke 2010), but can be summarised as:

- Do the questionnaire items reflect how the company actually performs the practice?
- Do the respondents believe that the company could/does address the items in the questionnaire in a better or different manner?
- During the interview did the respondent start to discuss a ‘pet’ subject which biased the interview analysis results?
- Can the ‘soft’ practices be adequately documented to reflect their application at the company?

There are some instances where a practice mismatch is common between companies, thus suggesting that the questionnaire may not be able to cater for the different ways that a company operates and this is more likely for certain practices. Another consideration is that the practice codes had to emerge from the data, as they were not used directly, which has also hindered the search for links.

The pattern codes that were left to emerge from the data provide most of the evidence to generate the conclusions concerning the research questions. In all cases the pattern codes provide significantly more data than the classifying codes. In addition, as can be seen from Table 4.3, the general pattern for the spread of the data obtained from the interview and documentation is very similar across all the companies suggesting that the differences between the respondents is not a major influence and hence the data is reliable. This supports the selection of the method of data coding, reduction and analysis.

Finally it can be concluded that the different data sources provided rich data that has contributed to reliable and valid conclusions. However, occasionally, particularly in terms of the quality practices, some conclusions could not be established, but this could be due to the fact that the companies do not recognise 'quality practices' per se and the questionnaire may not reflect what actually happens at the companies.

4.6.4 Implications and Recommendations

It is considered that the analysis findings can be considered as reliable and valid as a suitable robust methodology has been followed. Further research at Company D would provide increased confidence in the results and more confidence in the network diagram. However as the overall pattern of results for Company D closely reflects the findings from the other companies, the uncertainty in the results can be seen as minimal. If this research was to be repeated there are two specific recommendations:

- Check that the companies fit the required profile prior to visits rather than relying on recommendations.
- Ensure interviews with the most appropriate people.

Finally, semi-structured interviews provided the rich data required, but a way of establishing trust at the interview, in order to gain access to more documentation is needed. Whilst the questionnaire provided a significant amount of data for analysis, a closer match between the content of the questionnaire and the research objectives is preferable. However one purpose of the questionnaire in this study was to determine how this research contributed to and aligned with the existing research, so the questionnaire selected was appropriate for use.

4.7 Discussion and Framework Creation

The research method used has produced a reliable and valid set of conclusions which require further refinement and harmonising. The conclusions from the case studies have found that the relationship between a company quality programme, quality practices, quality activities and performance is different to that articulated in the academic quality-orientated research which views quality performance results as outputs of the activities rather than drivers, as shown in the generic network diagram (Figure 4.6). This generic network diagram can be refined to incorporate the other main conclusions emerging from the research:

- The quality programme is a 'label' and framework to provide a structured approach to focus on what quality activities are done and why.
- The quality programme enables the quality activities to be embedded in the way of working at the organisation.
- The quality programme focuses on the customer and more widely stakeholder satisfaction. Though this is operationalised through performance objectives.
- The use of a variety of quality activities is a fundamental part of the quality programme and their application is driven by performance measures and targets.
- A system for selecting which quality activities to deploy and then evaluate their effectiveness is required. This link/relationship requires formalising and a system for making the connections and enabling objective evaluations to take place would be beneficial. A feedback and review process is required which enables the effectiveness of the quality activities to be reviewed in the context of their contribution to the strategic aim of the quality programme.
- The use of the phrase quality practice and the strategic academic-generated practice names could not be found and neither could a link of these to company quality programmes.

These key points have been taken and used to modify the generic network diagram, to create a Quality Programme, Quality Activity and Performance framework (Figure 4.7).

4.8 QPQAP Framework Theoretical Discussion

Research (Miles and Huberman 1994) has suggested that the final stage of qualitative research should include a phase where the results are compared to existing research in order to look for support for the proposals. The support will be looked at from both a framework and research methodological perspective.

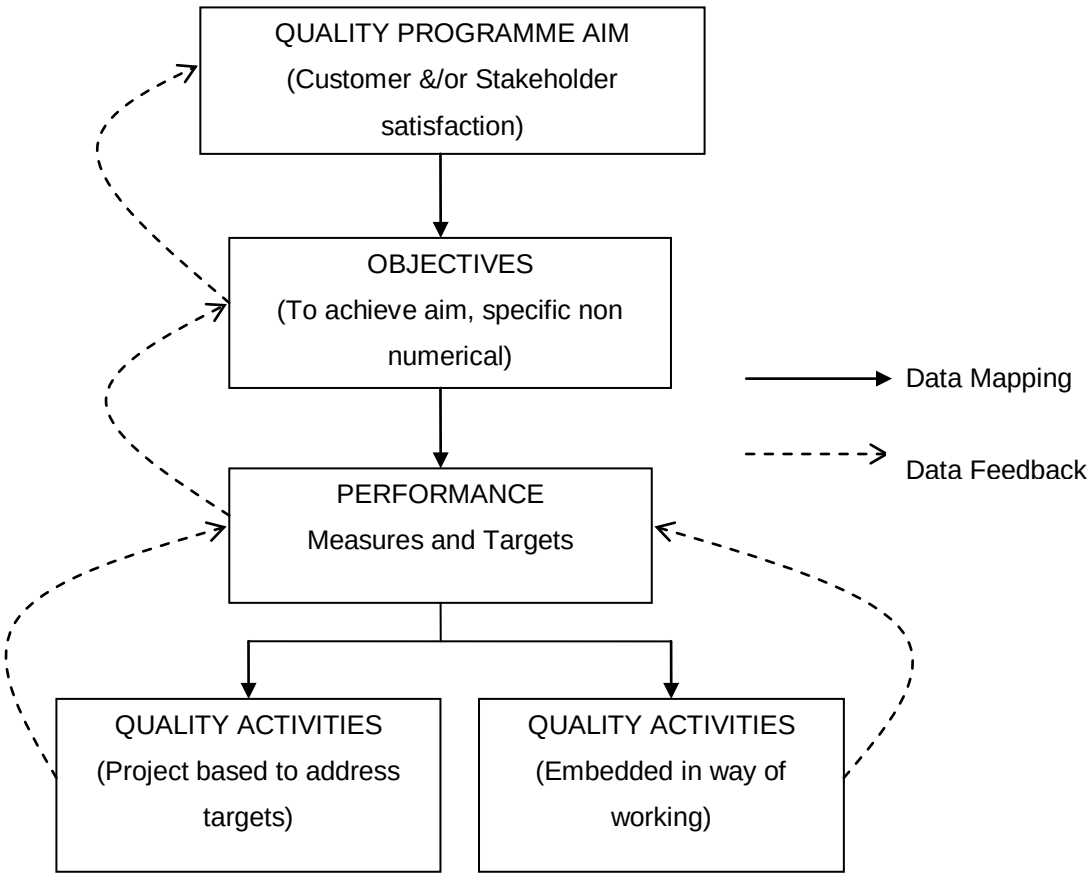


Figure 4.7 Quality Programme, Quality Activities and Performance (QPQAP) Framework

Research (Dale *et al.* 2001, Leonard and McAdam 2004) have identified the need for further theory development in the area of TQM research. In particular, "there is a need for evaluative models of TQM, which address the dynamic effects of TQM at strategic, tactical and operational levels" (Leonard and McAdam 2004). It is proposed that the QPQAP framework addresses this need. The first two boxes of the framework address the strategic need, the performance measures and targets take account of the tactical element, and finally the quality activities occur at the operational level. Chang *et al.* (2003) recommend that an organisations quality capability must be aligned with the organisations business strategy, which the QPQAP framework facilitates.

An Improvement Deployment Method was created (Carpinetti *et al.* 2000) to provide a "conceptual framework for strategy related continuous improvement". However, this method groups improvement actions into one element and does not consider how they will be fulfilled and although it includes an "implement and review" phase 'all-in-one' this does not capture the dynamic nature of TQM, and the authors acknowledge the managing of the feedback and progress review requires further work. The authors make a number of suggestions concerning how organisations identify which improvements should take priority and how to establish which ones have the most impact, but does not suggest a method. Further research (Carpinetti *et al.*

2003) presents event-driven process chain diagrams (EPC) to describe the activities necessary to define processes for improvement. However it has divided the “deploy and prioritize” from the “implement and review” process which is integrated on the QPQAP framework and thereby promotes the dynamic element of TQM.

Other research (Leonard and McAdam 2002a) found that organisations had their own approach to TQM and in particular used a variety of philosophies, tools and techniques. This is consistent with the findings of this research and the QPQAP model is sufficiently generic to enable organisations to define the content of each of the steps. This also supports the theory that TQM is context specific.

Some research (Pun and Gill 2002, Ingle 2000) has advocated that before implementing TQM or associated quality practices it is necessary to align them with the organisations goals, objectives and measures. In fact, Pun and Gill (2002) proposed three steps to EI/TQM implementation comprising: planning in terms of goals, objectives, critical success factors, performance analysis; integration consisting of improvement programmes/projects and practices; and the last stage installation which was the improvement methodology. The installation phase identified two types of improvement: kaizen or small improvements and; radical re-engineering type improvements. Therefore the Pun and Gill (2002) work supports the QPQAP model. Also, research (Palmberg and Garvare 2006) separated improvements in to “big” and “small” categories which align with the embedded into the way of working and project-based quality activities identified in the QPQAP model.

With regard to Quality Practices, which were originally suggested as the tactical level in the proposed framework (in the literature review Figure 2.8), research (Behara and Gunderson 2001) concluded “all empirical studies have some gaps in the coverage of their constructs, reiterating the need for continued quality management theory building research”. This work has investigated the existence of quality practices, directly (through interview questions and questionnaire completion) and indirectly (through transcript analysis) and found that both within organisations and in comparisons between organisations it was difficult to establish the existence of quality practices. This supports the need for more research in the quality practice area. It was also notable that organisations did not refer to the phrase which may be a result of the lack of consistent terminology which exists in the TQM research topic.

The Quality Practices (tactical level) have been replaced by a focus on performance measurement which was not part of the original proposed framework. The QPQAP framework suggests that performance measures should be used to guide the application of quality activities and bridge the gap between the strategic and operational levels. Several researchers (Najmi and Kehoe 2001, Sinclair and Zairi 2001, McAdam and Bailie 2002) have all identified a need to link strategy and performance measures to effectively implement TQM, and in

particular, “successful use of performance measurement appears to be closely linked with the level of integration of TQM into strategic and operational measures” (Sinclair and Zairi 2001). Therefore the inclusion of performance measures is consistent with other existing research.

Montes *et al.* (2003) propose a model linking TQM and performance, through “soft” approaches such as learning and behavioural processes, however, the nature of the relationships are complex and further work to investigate them was recommended. Examination of performance measurement and management frameworks found a “closed loop deployment and feedback system for the performance management process” (Bititci *et al.* 1997) which starts with an organisations vision, followed by business objectives, strategic goals, critical success factors, critical tasks action plan and finally ending with performance measures. They also describe a “reference model for integrated performance measurement systems” which operates at a corporate level, business unit level, business process level and activity level, though does not link to specific activities. Together these frameworks have synergies with the QPQAP framework. Research by Chang and Sinclair (2003) has developed a Total Quality based performance measurement system. This system focuses solely on performance measurement and the strategic focus of the system and does not consider the operational elements of managing the activities for improvement. Therefore it supports the first two boxes of the QPQAP framework.

Research (Yusof and Aspinwall 2001) investigated TQM implementation in SME’s and examined four, non industry specific case studies based on organisations that had implemented TQM. They reported difficulties in obtaining information, particularly concerning confidential information which was a difficulty encountered in this research. Interviews and document retrieval were the mains sources of evidence. Therefore their research methodology aligns with that contained in this thesis and offers additional support for the methodological approach followed. Research (Lewis *et al*. 2006) conducted case studies in four organisations to examine TQM implementation, and Venkatewswarlu and Nilakant (2005) used five case study organisations to examine TQM programmes. Whilst Tan and Platts (2004) used four case study companies to test software designed to link manufacturing objectives to action plans. Therefore although this research has been based on a small sample size, this is typical within the current research field when investigating similar fields. The research methodology (section 3.5) was designed to maximise validity and reliability issues despite the intended small sample size, and the analysis has focused on analytic generalisation. This method is valid since other research has been shown to support the issues raised from the case study investigations.

Therefore it can be proposed that there is research available which supports the research method used to develop the QPQAP framework and there is a selection of research which supports differing elements of the content of the QPQAP framework.

4.9 Chapter Summary

The most appropriate method of summarising this chapter is to associate the findings to the research questions posed earlier in the introduction to this chapter.

- *Which are the quality practices and activities that comprise a company quality programme?*
  Quality practices do not formally exist within the quality programme. The existence of the practices varies between companies. Although different companies use differing quality activities, yet the quality activities are the main element of the quality programme.

- *How is the company quality programme operationalised?*
  The quality programme consists of quality activities which have been designed into the way of working at the company and/or deployed within a project-based approach to address certain performance measure targets.

- *What are the aims and objectives of the quality programme and therefore the quality practices and quality activities?*
  The primary aim is customer satisfaction, although a broader more inclusive aim is stakeholder satisfaction. These are the aims of the quality programme and quality activities as the companies do not recognise quality practices.

- *Is there a link between the quality programme practices and the actual quality activities deployed? Can the link between quality practices and quality activities be mapped to indicate alignment?*
  There is not a link between the quality programme, the quality practices and quality activities. A link between the programme aim, objectives, performance measures and quality activities could be mapped. Although companies review the performance measures, they do not directly evaluate the effectiveness of the activities and cannot confirm whether they are using the most suitable.

A review of the effects of the research methodology on the research conducted found that the approach followed produced valid and reliable results which were then used to create the Quality Programme Quality Activities and Performance (QPQAP) Framework (Figure 4.7). The next stage in this research is the development of the QPQAP Framework.

5.1 Introduction

The purpose of the Quality Programme, Quality Activities and Performance (QPQAP) framework is to enable managers to plan and manage organisations manufacturing quality activities in line with the organisations strategic quality aims. The QPQAP framework, when deployed must provide managers with sufficient information to facilitate decision making about the quality activities being undertaken, so that decisions concerning use of activities, resources (time and people) can be made, and the quality activities can be adjusted accordingly to manage quality performance in line with company objectives.

The aim of this chapter is to critically evaluate alternative methods of deploying the QPQAP framework. The chapter will describe the selection and development of a suitable methodology and its subsequent deployment. Finally, the deployment process will be fully explained using examples to illustrate the process.

5.2 Deployment Method Selection

5.2.1 The QPQAP Framework

The framework was developed in chapter 4 (section 4.7) and is shown in figure 5.1. By analysing the QPQAP framework it is possible to determine the criteria which must be fulfilled if it is to be successfully deployed. The deployment method should be able to:

- Manage four levels of deployment and four criteria. *Note that the fourth level, Quality Activities, has been illustrated separately to emphasise the types of quality activities that emerged from the research, but in the deployment method should be considered as one.*
- Map two adjacent levels (criteria) against each other.
- Accommodate performance measures and targets and logically manipulate numerical data.
- Be easy to use, preferably already used by manufacturing organisations so minimal training is required. Simple to modify and flexibly accommodate changes in terminology and application without confusing existing users of the method.
- Reflect the language of the management, shop floor and all users in between and be simple to understand.
- Enable improvement activities and priorities to be determined (and therefore resources allocated).
- Incorporate (or already include) a feedback or review process in order to check quality activities align with strategy and facilitate the analysis of their performance.

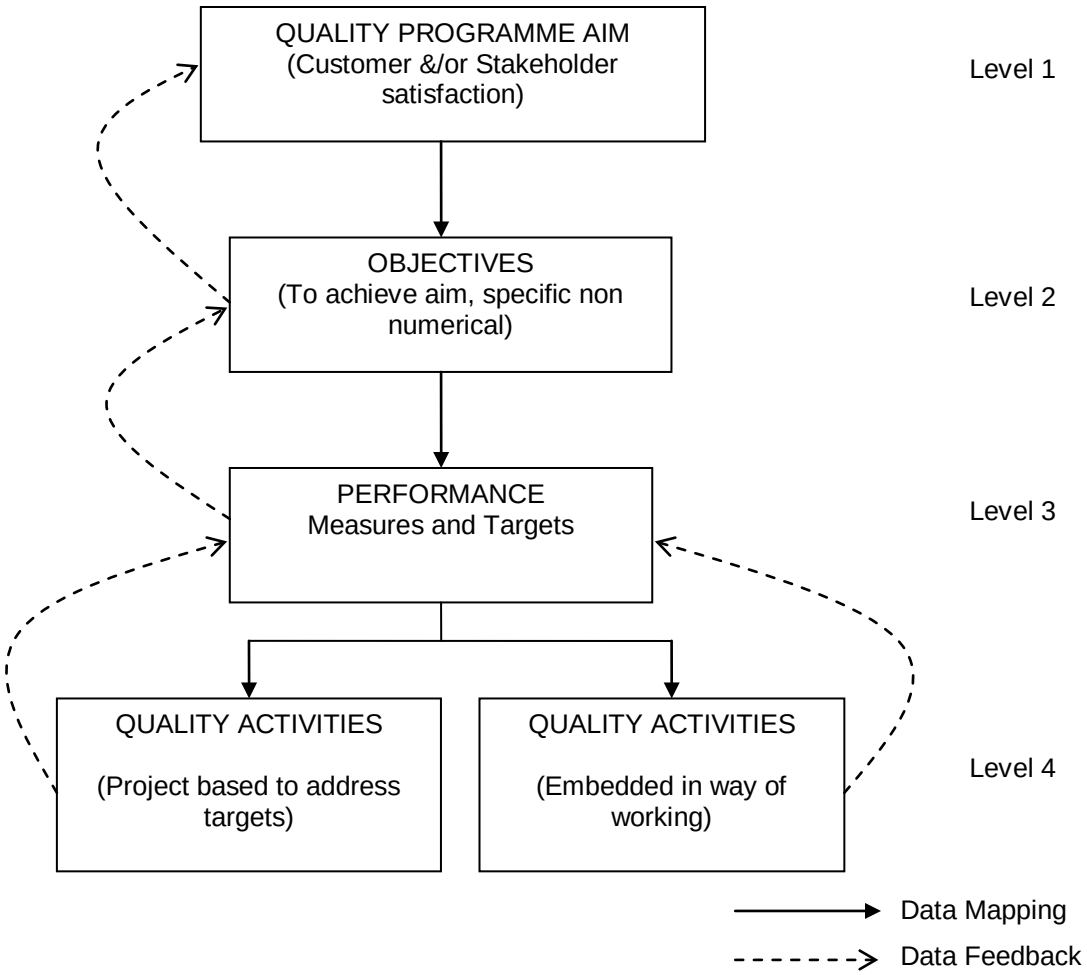


Figure 5.1 Quality Programme, Quality Activities and Performance (QPQAP) Framework (Repeat of Figure 4.7)

5.2.2. Alternative Deployment Methods: a Comparison

The literature review (Chapter 2, section 2.3) investigated, critically reviewed and compared the three predominant techniques for strategic quality management and its deployment: Balanced Scorecard (BSC), Hoshin Kanri (HK), and Quality Function Deployment (QFD). The literature review concluded that QFD has emerged most strongly as a generic technique suitable of being adopted and adapted to suit a varied range of applications. Of the three techniques, QFD was found to be the most flexible and easily adapted, and the quantity of applications in a range of environments suggests that employees across an organisation in a variety of roles would be familiar with the technique. However it was noted that all three techniques demonstrated that they enabled connections and linkages to be made between the data, suggesting that any of the techniques could be suitable, so that a further specific analysis should be conducted. Therefore how easily could each of the techniques be used to deploy the QPQAP framework, and in particular fulfil the criteria identified in 5.2.1? In order to answer this question the techniques have been compared against each other (Table 5.1), and then ranked (1 = best, 3 = worst) based on their ability to fulfil these criteria.

Requirements	BSC	HK	QFD	Comments/Justification
Manage 4 levels of deployment and 4 criteria (connections/linkages).	3	1	1	BSC developed to connect strategy to operations but not through "levels". The BSC has 4 pre-determined strategic perspectives so would need significant modification.
Map adjacent levels of 2 criteria (connections/linkages)	3	1	1	HK and QFD are designed to map different levels of criteria against each other. BSC maps differently so would need modification
Accommodate performance measures/targets and logically manipulate numerical data	1	3	1	BSC and QFD can accommodate and include performance measures.
Easy to use and known to manufacturing organisations	2	3	1	Refer to Literature review and Table 2.8
Simple to modify and accommodate changes in terminology/applications without confusing existing users	3	3	1	QFD has been widely adapted for use. Refer to Table 2.8
Understood by all employees/users	3	3	1	QFD has been widely used across a variety of applications.
Identify improvement activities and priorities	1	1	1	All techniques would require modification to meet this requirement
Feedback/review process to check alignment and performance.	3	1	3	HK has most rigorous feedback process, BSC and QFD would need adaptation.
Total Rank score	21	16	10	
Final Rank	3	2	1	

Table 5.1 Comparison of QPQAP potential deployment techniques with rankings

Examination of the criteria in 5.2.1 and Table 2.8 reveals overlap in terms of "easy to use", "understandable across employees in the organisation" and "simple to modify and flexibly accommodate changes". In all three of these criteria QFD was found to be the best technique which justifies a Rank 1. Review of the criteria concerning the mapping and managing of the data (the connections/linkages) shows that both HK and QFD could equally fulfil the QPQAP framework needs, ranking 1 each, but due to requiring significant modification to achieve the framework requirements BSC ranked 3. It is considered by the author that this factor alone eliminates the use of the BSC. Both BSC and QFD were created to evaluate performance data and manipulate numerical and non-numerical data but HK was not specifically designed for managing performance data which justifies its rank of 3. Each technique was weighted equally for the criteria concerning identifying improvement opportunities, as each would need modification. HK includes a feedback/review process and hence is ranked first for the final criteria concerning feedback/review, whilst both BSC and QFD would require adaptations.

The scores show a little difference between the techniques although indicates that QFD is the most appropriate technique to deploy the QPQAP framework. In addition to the general and specific analysis, there is a broad spectrum of research which supports the use of QFD, from both a logical communication perspective and its adaptability and suitability in a strategic

management application. ReVelle *et al.* (1998) though focusing on QFD application for customer demands for products/services state "QFD provides … a set of matrices that serves as both a structure and a graphic of the deployment process". It is through the structure and order it enforces along with the charts (graphic) which demonstrates "it is a communications tool, a vehicle for dialogue" (Shillito 1994), which in turn, facilitates the comparison and objective evaluation of a number of activities, by using weights (scores) against the criteria to assess performance and importance. Consequently decision making should be discussed and therefore more considered and less intuitive thus enabling priorities to be set and decisions made about the activities the organisation participates in. QFD has been widely used by research for strategic planning and setting action plans (for an overview see Hunt and Xavier 2003) and it has also been found that researchers have made small/minor changes to QFD in order to accommodate their own research. For example, ReVelle *et al.* (1998) describes how QFD was modified to handle designing products for mass customisation, designing a service, software development (the matrix has no roof) and presents applications of QFD including education and training (curriculum design), to develop JIT manufacturing philosophy, quality system analysis, design and implementation. QFD has been described as a "robust tool" (ReVelle *et al.* 1998), with "applications limited by one's imagination" (Cohen 1995).

To conclude, QFD has been selected over BSC and HK because it:

- Is a structured methodical and logical method for connecting/linking data;
- Provides a basis for communication and is well used especially in manufacturing organisations;
- Handles numerical and descriptive data;
- Can be adapted to meet the QPQAP requirements, specifically concerning the feedback/review process and identification of improvement opportunities.

The author acknowledges that the other techniques (BSC and HK) could possibly be used to deploy the QPQAP framework and as such could potentially be future research. However, this research has demonstrated that QFD is currently the most appropriate to select. Therefore QFD and particularly the "Hauser and Clausing four-phase model" used for product development (Hauser and Clausing 1988) will be adopted and modified to deploy the QPQAP framework.

5.3 Deploying the QPQAP framework using QFD

In order to adapt QFD to deploy the QPQAP framework it has been necessary to align the two methods with each other and then correlate them in order to create the QPQAP deployment process. This alignment and correlation process is illustrated in a diagram, Figure 5.2 Generation of Deployment Process:

1. Viewed from left to right it shows the evolution of the deployment process from the QPQAP Framework (on the left) to the QFD four phase process (Hauser and Clausing 1988) (centre) to the Deployment Process (on the right).
2. Viewed from top to bottom it shows the 4 sequential phases of each of the three processes (QPQAP Framework, QFD and Deployment Process).

Therefore, the diagram should be read from left to right; for example, phase 1 “Quality Programme Aim” (as shown in QPQAP framework) aligns with “Chart 1 Product Planning” (in the QFD Process), and this in turn aligns with “Strategic Requirements Planning” (in the Deployment Process). Consequently Phase 2 of the QPQAP framework “Objectives” aligns with QFD Process Chart 2 “Design Planning” which in turn aligns with the Deployment Process “Performance Objectives Planning”.

The close alignment between the QPQAP Framework and QFD has meant that at this generic process level only the wording of each phase needed to be changed to create the Deployment Process and that the QFD technique remains unchanged. Each phase of the Deployment Process has been named to reflect the nature of the mapping activity being undertaken.

5.3.1 Definitions

In order to understand the deployment process it is necessary to provide definitions for the items within it, along with academic and practitioner examples. The practitioner examples were obtained during the participant observation research conducted for the investigation into operational quality activities and employee involvement. It should be noted that these are “working” definitions and further research is required to test and develop them and provide more detailed practitioner orientated examples.

5.3.1.1 Aims

These are the strategic quality aims of the organisation. They may be articulated as such or derived from the organisations mission statement or similar. Therefore the aims are strategic and high-level in nature and consequently non-specific (vague). They can be interpreted company-wide since they are not departmental or function specific. For example, research (Stone and Banks 1997) suggest strategic level emphasis on profitability, customers, employees and productivity whilst others (Najmi and Kehoe 2001) believe the three main aims are the dimensions of quality, time, and finance. Other practitioner–based examples could include: customer satisfaction, customer awards, increased sales, and increased profit.

It is recommended that the aims align with quality principles identified in the literature review (section 2.7).

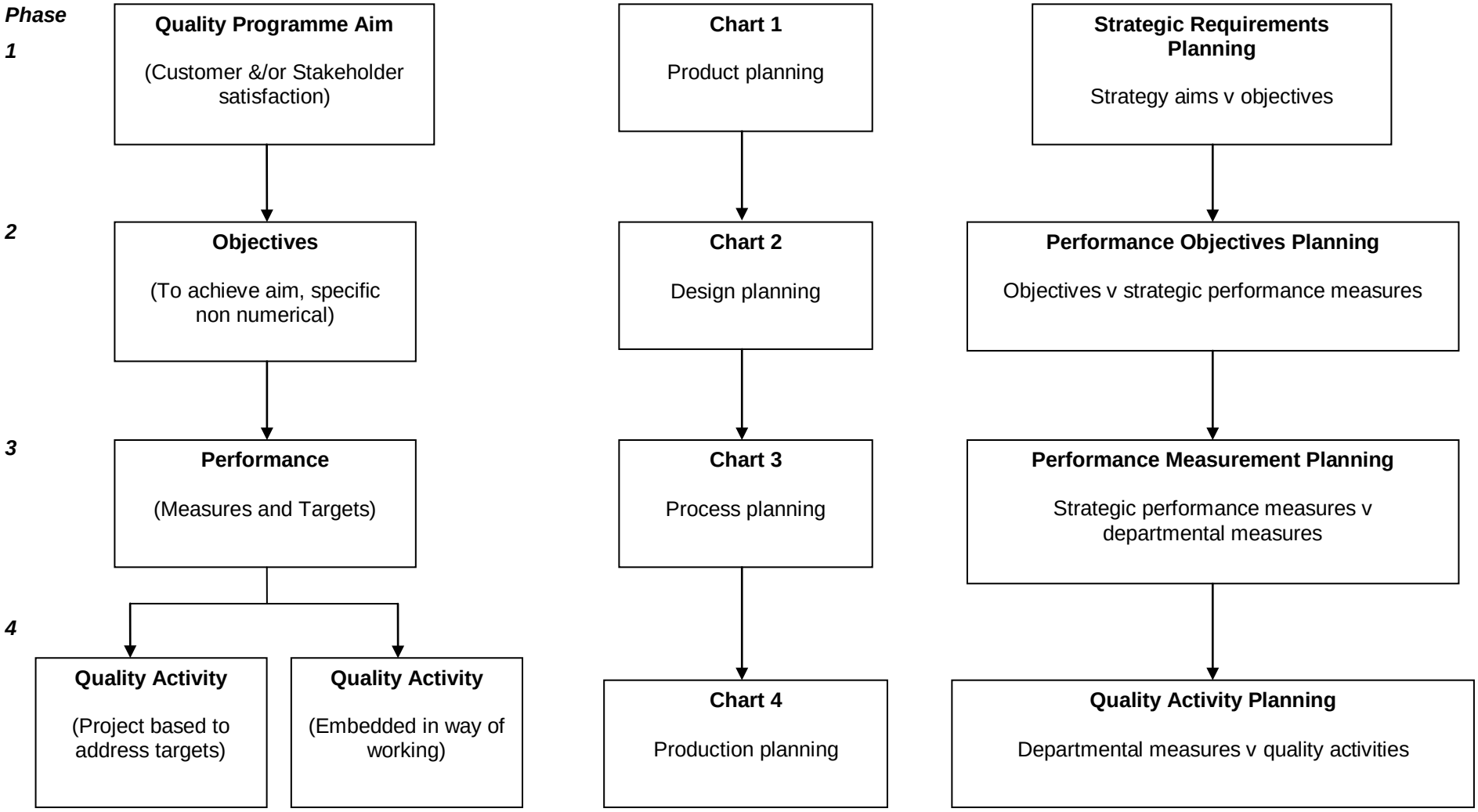


Figure 5.2 Generation of Deployment Process

5.3.1.2 Objective Requirements

The purpose of the objective requirements is to fully articulate the aims and expand them to provide a departmental/functional focus, for example manufacturing focus. These should be long term quality-orientated objectives which align with the organisations aims. However objective requirements remain strategic and generic in nature and are non-numerical. For example, these could include Garvin's (1987) eight dimensions of quality performance: product reliability, product durability, conformance to specifications, design quality, company reputation, pre-sale customer service, product support, responsiveness to customers. Alternatively, may include, continuous improvement (Tena *et al.* 2001, Dean and Bowen 1994), delivery reliability (White 1996). Other, practitioner-orientated items could include: on-time delivery, responsiveness to customer, quality improvements, waste (cost) reduction.

5.3.1.3 Strategic Performance Measures

Each objective requirement is evaluated to determine appropriate long term, strategic descriptive performance measures. These strategic performance measures are specific to the function/department (for example, manufacturing) yet generic enough to be understood and applied to all relevant areas within the function. These should be specified non-numerically although should facilitate a numeric target being allocated. For example, academic measures for strategic quality performance may include: quality costs, internal failure costs, percent defective (Adam *et al.* 2001), manufacturing improvement goals: manufacturing conformance, product quality, product reliability, customer service (Acur *et al.* 2003) and inbound (supply) quality (De Toni and Tonchia 2001). Practitioner derived measures could include: Non-conformance costs, reduction in production permits/waivers, batches with zero defects, audit non-conformances, supplier rejects, customer complaints.

5.3.1.4 Department Measures

Departmental performance measures (may be known as Key Performance Indicators (KPI's)) are specific performance measures which have been created to translate the strategic performance measure into operational function specific measures relevant to a specific known functional area. These should be operational in nature and monitored frequently, for example on a daily, weekly or monthly basis. Typical academically identified measures can include: customer complaint statistics, defects per unit, defects per 100 units, defective percentages, first pass ratio %, incoming material quality level, mean time between failures, number of rework units, % defect free vendor delivered, % field failures, process quality and process yield percentage, supplier outgoing quality levels (Lochamy 1998) and total cost of quality, rework cost, inspection cost, average % items defective, returns and warranty costs, internal waste/ scrap costs (Adam *et al.* 2001). Many authors (Najmi and Kehoe 2001, White 1996, Grady 1991, Cagliano *et al.* 2001, Corbett and Rastrick 2000, Lee *et al.* 2001) have identified

measures suitable for this category. Practitioner department measures include: quantity waste material, scrap costs, right first time % and number audit non-conformances.

5.3.1.5 Quality Activities

Activities are the specific tasks being performed within the function/department on a regular basis such as daily, weekly or monthly or as one-off activities which comprise part of a project. (For a definition and examples refer to Literature Review section 2.5).

5.4 The Deployment Process

5.4.1. QFD Chart

Although one of the earliest published charts is the Hauser and Clausing (1988) House of Quality, due to the adaptations for alternative applications a generic version is presented (figure 5.3).

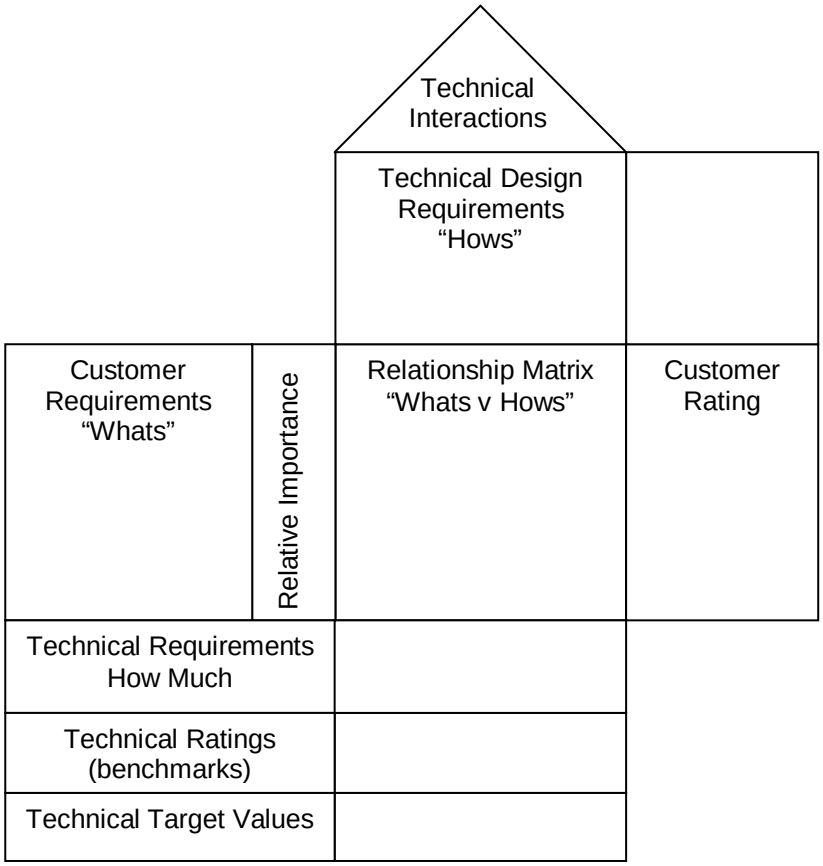
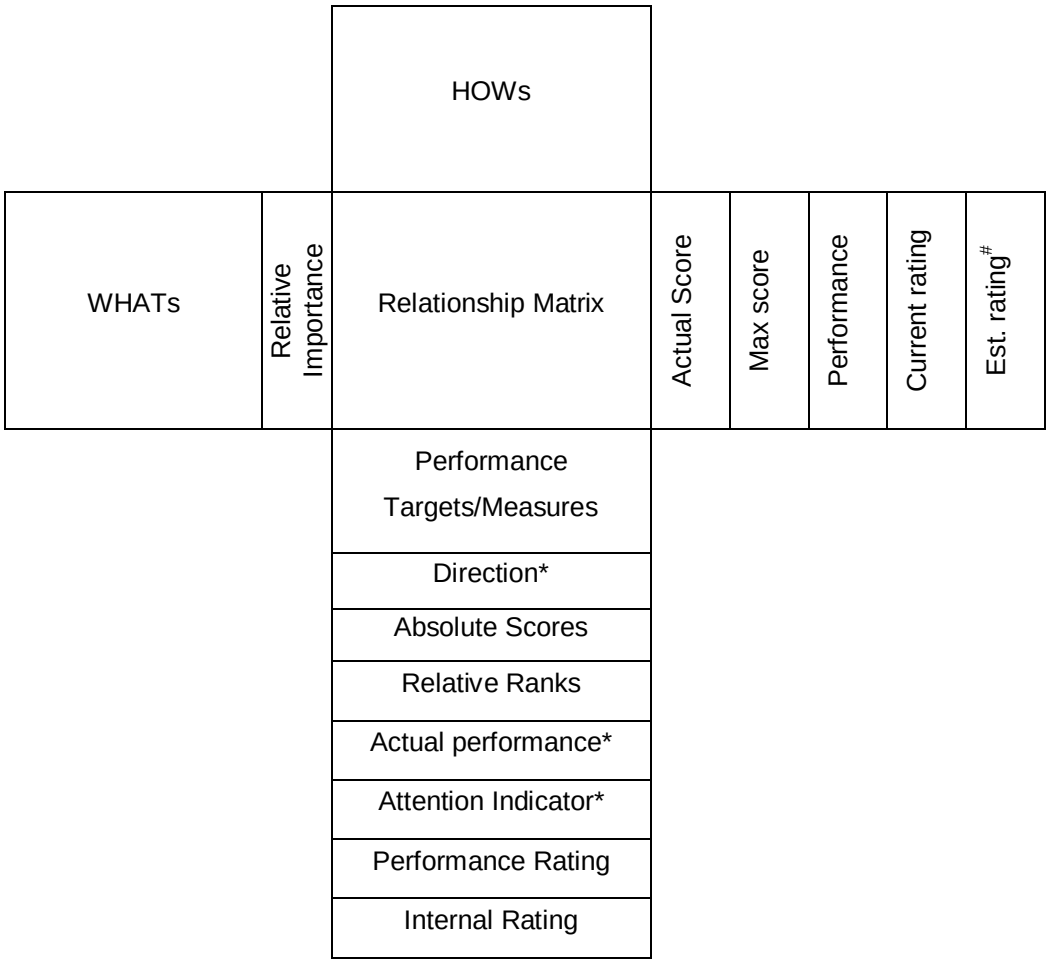


Figure 5.3 Typical House of Quality (adapted from Oakland (2003))

The House of Quality is also known as the QFD chart, and will continue to be referred to by this name in this thesis. The purpose of the QPQAP framework (as illustrated in Figure 5.1) is to translate the quality strategy into performance objectives, which in turn are translated into performance measures and targets which are finally linked to quality activities. This process is internally focused and a significant proportion is performance measure orientated in order to ensure that these measures are documented, linked and mapped through the four phases. In addition, there is a need for the chart to accommodate the data which emerges as a result of the feedback process (Figure 5.1).

Examination of the QFD Chart (Figure 5.3) in this context reveals that particular parts of the matrices need to be adapted in order to handle all the required performance data and facilitate the resulting feedback process. An adapted version of the QFD chart has been created (Figure 5.4).



* these rows are only on Chart 4 Quality Activity Planning

this column is only on Chart 1 Strategic Requirements Planning

Figure 5.4 Adapted QFD Chart

In comparing the two charts (Figure 5.3 and Figure 5.4) it can be observed that the main body of the chart, the "What", "How", "Relative Importance" and "Relationship Matrix" remain unchanged. The Actual Score, Max Score, Performance Rating and Current Rating columns have been created to replace the Customer Rating matrix and articulate numerically the performance of the "Whats". The Current Rating and Performance Rating values are *the* critical data because they are used to feedback performance up to the next chart and therefore provide the links between the charts, a key feature of the QPQAP framework. The final column, Estimated Rating is a feature only of the first chart Strategic Requirements Planning, as it is entered by senior management (or customers) to capture the belief about performance against the "Whats" and is used for the final evaluation "Are the quality activities enabling the company's quality aims to be fulfilled?" which is the purpose of the frameworks in this thesis and the main aim of this research. The Performance Targets/Measures row is similar to the typical Technical Requirements (How Much) matrix as it is used for setting targets (i.e. How Much) for the "Hows". The Technical Ratings and Target Values (shown on Figure 5.3) are essentially equivalent to the Direction, Actual Performance and Attention Indicator and serve a similar purpose. These rows only exist in Chart 4 Quality Activity Planning within the QPQAP framework and are used to record the performance and enable management of the quality activities. These rows are used to record the *actual* performance data concerning the quality activities, as such it is the *only* data input point which is the basis for the Data Feedback process and subsequent performance analysis. It is *the* input which enables the question "Are the quality activities enabling the company's quality aims to be fulfilled?" to be answered. This is because the QPQAP Framework links the performance of these activities to the quality strategic aims though the final two rows, Performance Rating and Internal Rating, in Chart 4. These values are determined from the performance data entered in the Actual Performance row. In the other 3 charts, the Performance Rating and Internal Rating rows data is taken from the columns for Performance Rating and Current Rating in the preceding chart. It is this feature of the adapted QFD chart (Figure 5.4) that provides the data mapping and data feedback requirements specified in the QPQAP framework (Figure 5.1). It is noted that this adapted QFD chart does not have a "roof" and the Technical Interactions between the "Hows" are not part of the QPQAP Framework. The inclusion/exclusion of this feature could be an opportunity for future research and will be discussed in Chapter 8.

5.4.2 QFD Chart Completion

5.4.2.1 Overview

Each phase of the QPQAP Deployment Process is documented on an adapted QFD chart therefore four charts (one for each phase) will be completed. The QPQAP framework uses these simplified QFD charts at each phase of the deployment process to ensure that the data

flows and links one chart to another through the "What" to "How" conversion process (Figure 5.5). Completing the four charts is a two stage process to reflect the data flows: data mapping and data feedback that are identified in the QPQAP framework shown in Figure 5.1.

The Data Mapping – out phase is concerned with collating, presenting and mapping the correct company information in each chart across all levels of the framework. The emphasis during data mapping must be to ensure that the "What" to "How" translations are correct and all the relationships have been identified and documented on the charts. It is critical that the correct data is on the charts so that the organisation is monitoring, measuring and improving the right activities. Linkages, relationships and their weighting as articulated on the Relationship matrix must also be correct.

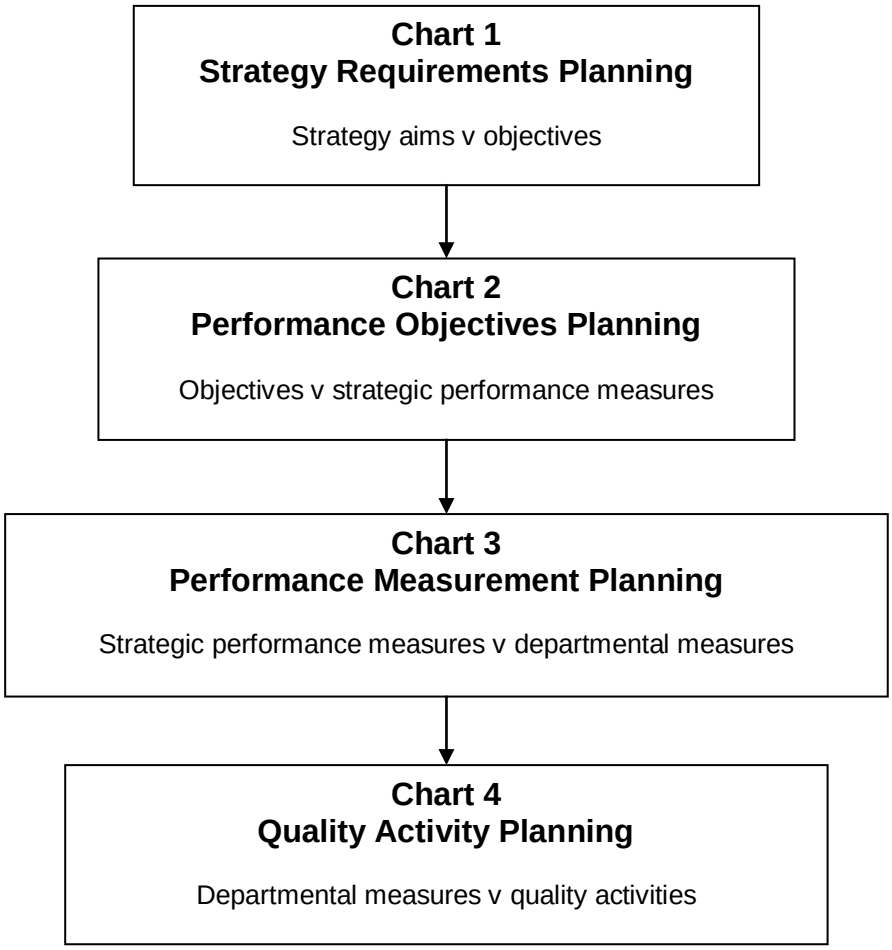


Figure 5.5 Data Flows cascading through the QPQAP framework during the Data Mapping phase.

The Data Feedback – return phase uses the four QFD charts for performance management which is a unique adaptation to the QFD process. Traditional charts are only used for establishing important criteria and then managing performance, trade-offs and fulfilment within the chart. The QPQAP framework goes beyond the traditional within chart

performance management by linking the performance of all charts together in this Feedback Phase. Critical to the success of this performance management process is chart 4, Quality Activity Planning, where actual performance measures are recorded, rated and subsequently cascaded up through the framework. It is only at chart 4 where actual performance data is input to the chart. The data is transmitted through the charts, via the relationships, to be compared against the predicted performance of the strategic quality aims (in the Strategic Requirements Planning chart).

It is acknowledged that the four-phase approach whilst ensuring connectivity between data also means that any errors in the data will be transmitted through the charts, on the out and return phase. Therefore accuracy of data is an essential ingredient in the deployment of the QPQAP Framework. One of the strengths of the QFD chart is that it is known to facilitate communication and therefore it is anticipated that, a team approach to completion will promote accuracy within the charts.

5.4.2.2 Data Mapping – Out: Chart Completion

It is critical that particular attention to accuracy is taken during the data mapping phase because as the charts are completed their future reliability, and that of the QPQAP Framework is pre-determined. The data sources used to determine the "Whats" and "Hows" must be current, relevant and accurate, and the interrelationships between them interpreted and documented (mapped) with diligence. The main difference in chart completion during the data mapping phase is the measures and targets that are determined for each "How". In the Strategic Requirements Planning chart these are broad and descriptive, but increase in specificity as they cascade through the charts such that in the Quality Activity Planning chart the targets are numerical and specific for the activity being monitored. These differences are summarised in Table 5.2 and examples are included to highlight the differences. The arrows show that the data used for a "How" in one chart becomes the input data in the form of a "What" in the next chart, which demonstrates the data mapping and cascading down through the four charts. The integrity of these linkages and relationships establishes the reliability of the Framework and will determine whether the results and data presented in the Data Feedback – return phase reflects the true situation at the organisation. Failure to ensure these relationships are correct in the out-phase could mean that effective changes to the performance of the quality activities (as documented in QFD Chart 4, Quality Activity Planning) do not present accurately as they are cascaded up through the four charts in the return phase. It could also mean that performance data is unrealistic and targets may not be possible to achieve.

Phase	**Responsibility**	**Whats ?**	**Hows?**	**Measures / Targets**
SRP Strategy Requirements Planning	M.D. / CEO with strategic responsibility for quality	Few, general strategic (quality related) aims, derived from mission statement and quality policy e.g. customer preferred supplier	Non-numerical objectives (quality goals). Based on quality policy, quality principles and/or quality strategy. e.g. Maintain quality approvals	Descriptive, non-numerical measures. e.g. customer quality approvals
POP Performance Objective Planning	M.D. / CEO and senior management	Non-numerical objectives (quality goals) e.g. maintain quality approvals	Non numerical objective performance requirements Based on quality policy, principles and strategy and may be included in Quality Manual and quality procedures. e.g. maintain ISO9000	Numerical target for each performance objective e.g. zero outstanding audit non-conformances
PMP Performance Measurement Planning	Senior management and department manager	Organisation non numerical objective performance requirements e.g. Maintain ISO 9000	Department (numerical) performance measures Specified in procedures, management/dept plans e.g. Pass all internal audits	Numerical department performance targets e.g. zero outstanding internal audit non-conformances
QAP Quality Activity Planning	Department manager and cell leader (s)	Department numerical performance measures e.g. Pass all internal audits	Activities to contribute to performance measures. Specified in work instructions, company practices etc e.g. Adhere to procedures	Numerical target for each activity e.g. 100% internal audit non conformances cleared within 14 days

Shows data flows cascading through the QFD charts

Table 5.2 Summary of Chart Content and “What” to “How” linkages

The Data Mapping phase chart completion process follows the same general procedure for each of the four charts as shown in the flowchart (Figures 5.6). This is complimented by an annotated QFD chart (Figure 5.7) which indicates how the data at each stage of the flowchart should be entered on to the QFD chart.

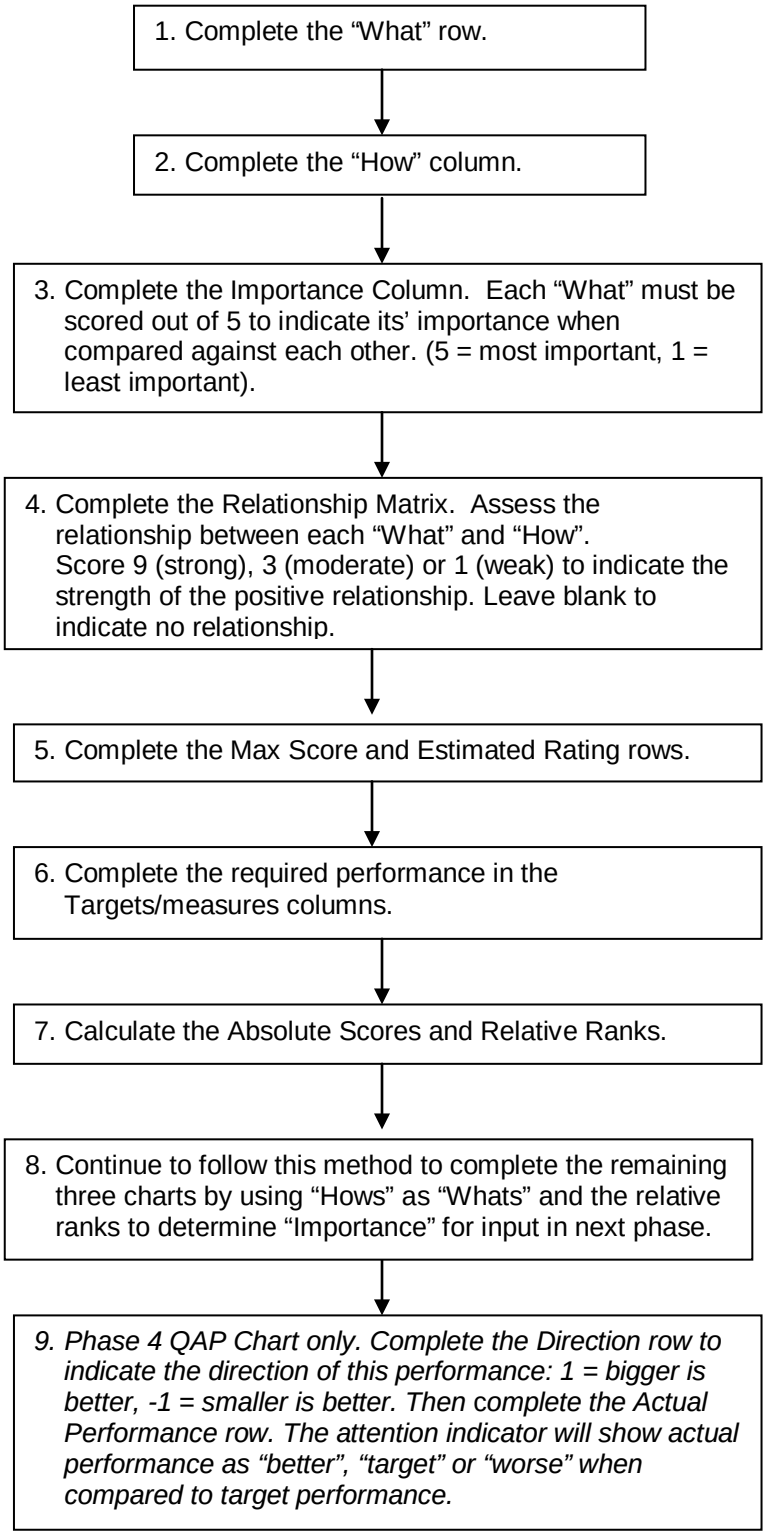
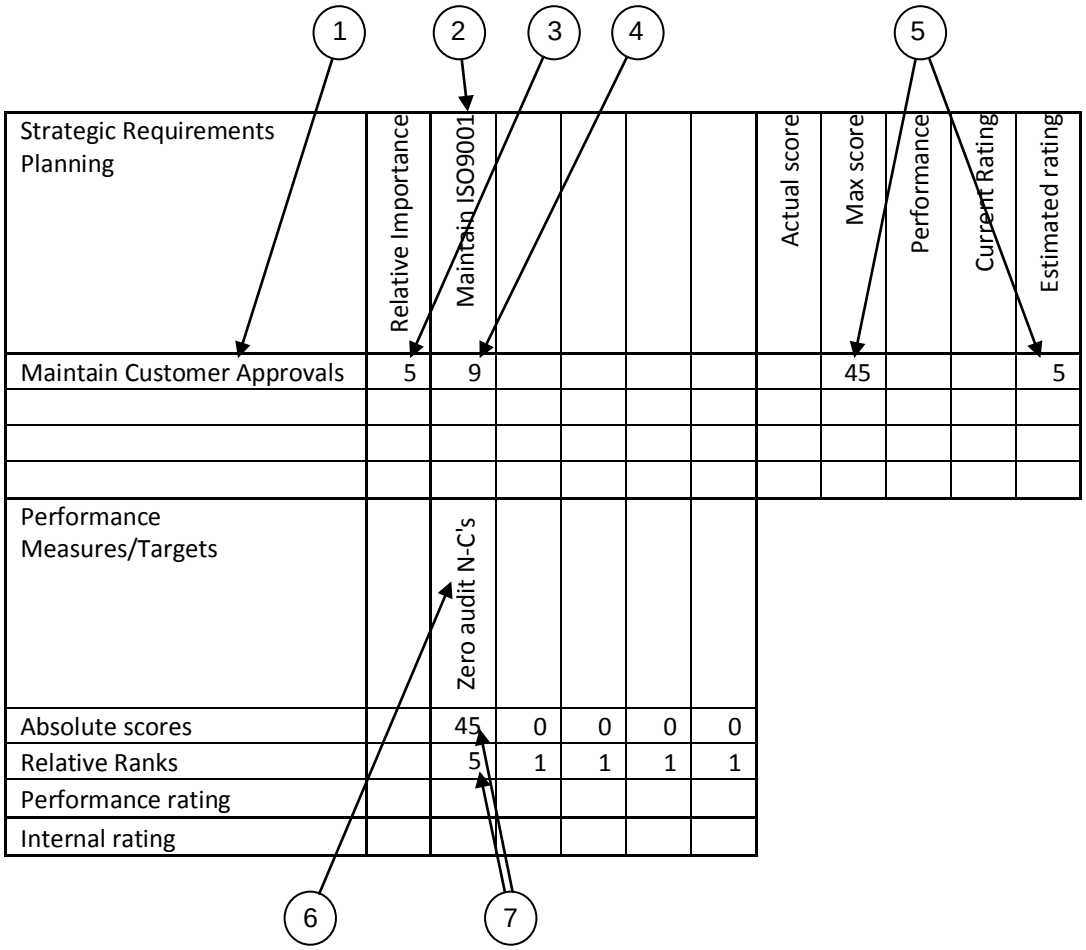


Figure 5.6 Data Mapping – "out": Chart Completion



Key: Items 1 to 7 correspond to Chart Completion Flowchart (Figure 5.6)

Figure 5.7 Annotated Adapted QFD Chart – Data Mapping

The Relationship Matrix is particularly important and must be carefully completed because the weightings are used to calculate the absolute scores and relative ranks for the "Hows" which in turn are used to determine the Relative Importance Rating for the "Whats" in the following chart. Due to this unique feature of the QPQAP Framework it has been necessary to adjust the standard QFD process so that the ranks are calculated inversely, that is the highest absolute score, rather than ranking 1, will now rank 5. In the data mapping phase the Relationship Matrix establishes the linkages and maps the relationship strengths which will in turn impact the performance value of the "Whats" during the Data Feedback – return phase. The Relationship Matrix should be independently verified after it is completed before moving on to the next chart.

Input data for the "Whats" and "Hows" should be derived from established company sources (as indicated in Table 5.2) firstly so that there is sufficient in-depth understanding behind the headings and secondly so it integrates into the company's existing business management systems. The QPQAP deployment process should sit and operate alongside existing

systems and not contradict or work outside them. This is essential for commitment to the QPQAP process and understanding the framework outputs.

The first two charts Strategy Requirements Planning (SRP) and Performance Objective Planning (POP), Figure 5.8 and 5.9 respectively, should be aligned to the organisations strategy and as such should be the responsibility of senior management with ultimate strategic responsibility for quality, for example the Managing Director or Chief Executive. Since this data is strategic it is unlikely to change and should therefore be reviewed for relevance and accuracy at the same time as the company strategy and quality policy are reviewed. However perceived performance in the form of Estimated Rating (SRP Chart) should be reviewed more frequently, for example, whenever a review of the quality activities performance has resulted in the data changing, cascading the changes up through the charts during the Feedback phase.

Strategy Requirements Planning	Relative Importance	Maintain ISO9001	Responsive to customer	Product performance (quality)	Delivery Performance	Cost reduction	Actual score	Max score	Performance	Current Rating	Estimated rating
Maintain Customer Approvals	3	9		3			33	36	0.9	5	5
Customer Preferred Supplier	4	3	9		3		39	60	0.7	3	5
Increased Sales	3		3		3		10	18	0.6	3	3
Increased profit	5					9	30	45	0.7	3	3
Performance Measures/Targets		Zero audit N-C's	Within 24 hours	Warranty returns	Ontime, In full	Savings £					
Absolute scores		39	45	9	21	45					
Relative Ranks		3	4	1	2	4					
Performance rating		1.0	0.6	0.8	0.6	0.7					
Internal rating		5	3	4	3	3					

Note: Rounding errors exist to simplify chart. For example, Performance Rating 0.7 is actually 0.66'. Calculations demonstrated later.

Relative Ranks inversely calculated as they translate into Relative Importance Ratings in subsequent chart.

Figure 5.8 Strategy Requirements Planning (SRP) – example chart

Performance Objective Planning	Relative Importance	Audit Non conformances	On time delivery	Cost of quality	Concessions/waivers	Schedule adherence	Score	Max	performance	current rating	estimated rating
Maintain ISO9001	3	9					26	27	1.0	5	
Responsive to customer	4		9			3	28	48	0.6	3	
Product performance (quality)	1			9	9		14	18	0.8	4	
Delivery Performance	2		9			3	14	24	0.6	3	
Cost reduction	4			9	3		32	48	0.7	3	
Performance Measures/Targets		Zero major N-C's	100% on time	< £2k per month	< 5 per month	100% adherence					
Absolute score		27	54	45	21	18					
Relative Ranks		3	5	4	2	1					
Performance Rating		1.0	0.6	0.6	0.9	0.7					
Internal rating		5	3	3	5	3					

Note: Internal Rating and Current Rating values link the QFD charts together (Data Feedback phase refers). Rounding errors exist to simplify chart.

Figure 5.9 Performance Objectives Planning (POP) – Example Chart

The Performance Measurement Planning (PMP) and Quality Activity Planning (QAP) charts, Figure 5.10 and Figure 5.11 respectively, are operationally focused and data should be gathered from department or local sources such as quality procedures and work instructions. Therefore the charts are completed by operational managers or team leaders, possibly under the guidance of the senior manager involved in completing the POP chart in order to verify the charts accuracy and completeness. These charts should be reviewed more frequently, as operational performance tends to be more dynamic than the strategy-based data used in SRP and POP charts. The review frequency should be determined by the organisation to reflect the changing business environment, and the nature of the data collected and input to QAP Chart. It is likely that this review process would be between three and six monthly. Too frequent a review could result in decisions being made which are not based on longer term trends but possibly a short term change/anomaly. Again the chart owners and internal customers should be conducting the review.

Performance Measurement Planning	Relative Importance	Outstanding audit n-c's	Machine usage	Right first time	Scrap Costs	Schedule changes	Score	Max	performance	current rating	estimated rating
Audit Non conformances	3	1		9			29	30	1.0	5	
On time delivery	5		9			3	33	60	0.6	3	
Cost of quality	4	9					22	36	0.6	3	
Concessions/waivers	2	3			9		22	24	0.9	5	
Schedule adherence	1			3		9	8	12	0.7	3	
Performance Measures/Targets		zero outstanding	90% machine utilisation	95% RFT	% reduction	zero changes					
Absolute Score		45	45	30	18	24					
Relative Ranks		4	4	3	1	2					
Performance Rating		0.6	0.6	1.0	1.0	0.6					
Internal rating		3	3	5	5	3					

Note: Rounding errors exist to simplify chart.

Figure 5.10 Performance Measurement Planning – example chart

The QAP Chart (Figure 5.11) differs from the preceding three charts to include information concerning the quality activities performance:

- Direction: to indicate for the performance target whether bigger, target or smaller is better
- Actual Performance: the actual performance value for the quality activity
- Attention Indicator: to show performance against target

However, as indicated in Figure 5.6 and Figure 5.11 the Quality Activity Planning chart is significantly different because it is used to start the focus on performance by closely examining the quality activities and their associated targets/measures. Therefore it includes a "direction" to indicate whether the measure/target should be bigger or smaller. When the actual performance is added to the chart then it can be calculated whether this is "better", "worse" or equal to target, which is shown on the "attention indicator" row. This provides an instant visual alert to what is happening and particularly the activities which are not meeting targets and therefore where action is required.

Quality Activity Planning	Relative Importance	no. outstanding n-cs	Statistical Process Control	OEE Availability rate (TPM)	% pass inspection and test	Kaizen activity changes/mth	Actual score	Max score	Performance	Current rating	Estimated rating
Outstanding audit n-c's	4	9					22	36	0.6	3	
Machine usage	4			9	3		26	48	0.6	3	
Right first time	3		9		9		54	54	1.0	5	
Scrap Costs	1		9		9		18	18	1.0	5	
Schedule changes	2			1		3	4	8	0.6	3	
Performance measures/targets		0	1.33	85	98	0					
Direction		-1	1	1	1	-1					
Absolute scores		36	36	38	48	6					
Relative Ranks		2	2	4	5	1					
Actual Performance		2	1.5	80.0	99	5					
Attention Indicator		worse	Better	worse	better	worse					
Performance rating		0.6	1.0	0.4	1.0	0.6					
Internal rating		3	5	2	5	3					

Note: Rounding errors exist to simplify chart.

Figure 5.11 Quality Activity Planning (QAP) – example chart

The performance measure/target is a company specified measure; therefore it does not mean that it is necessarily the optimum value for the "How" under scrutiny. It may be that the target is an internal short term goal which is regularly revised. Therefore achieving target should not be viewed as over performing. Similarly better does not mean "best" as the company may not have set a challenging goal. As with all performance measurement and management systems it is only as effective as the manner in which the company implements it. Therefore the attention indicator row should be interpreted carefully within the context that the performance measures/targets were set.

It is particularly important when completing the Quality Activity planning chart to have SMART (specific, measurable, achievable and realistic targets) measures which reflect the quality activities and are clearly linked to them. It is essential that the measures represent only the quality activity under scrutiny and are not affected (either adversely or positively) by other quality activities including those in other departments.

The data mapping – out phase is shown in Figure 5.14 on the left hand side of the diagram with 'typical' data/numbers added to demonstrate the process.

5.4.2.3 Data Feedback – Return: Chart Completion

The objective of the Data Feedback process is to facilitate performance management, enable continuous improvement and ensure the QPQAP Framework (Figure 5.1) is a dynamic process. The research outcomes documented in Chapter 4 identified that performance targets drove the quality activities being performed but organisations did not check whether the activities were delivering against the performance measures. The companies did not formally establish linkages between the activities and performance measures (addressed in the data mapping process on the QFD charts). The absence of an evaluation mechanism meant that companies could not argue that the quality activities that were being performed were effective or the best ones to be engaging in. The Data Feedback phase addresses these requirements.

The Data Feedback - return process starts with the Quality Activity Planning chart and the entering of the actual performance values onto the QFD chart, followed by an objective evaluation of the performance of the quality activities – how well are they performing against their target? Based on this judgement a score is added to the Internal Rating row to reflect the performance of the quality activity. It is essential that this is scored consistently, with integrity and in multi-department organisations a manager with responsibility across all the departments should be involved to ensure parity and equity in this process.

It is suggested that an organisation can quantify the Internal Rating Values to ensure consistency, for example:

100% Target achieved = score 5
Within 95% target = score 4
Within 90% target = score 3
Within 80% target = score 2
Less than 80% target = score 1

However, it should be noted that these values are recommendations, and it is likely that the values may vary between manufacturing processes, industries and even countries, and therefore an organisation should determine its own performance scale for the Internal Rating values. This topic offers opportunity for further research.

Performance of the quality activities should be judged on the departmental performance measures (or Key Performance Indicators (KPI's)) which are regularly monitored and recorded. Information concerning the application of the quality activities and detailed information to support, contradict and question the performance data would be beneficial since the performance data could be considered more meaningful and reliable and in turn the performance ratings can be deemed valid with increased confidence in them and the subsequent interpretation.

The Internal Rating is translated into a performance value for each "How", then used as a weighting factor to calculate an actual performance score against each "What". By taking this score as a percentage of the Maximum Score possible, a Performance Rating for the "What" can be determined which is converted into a Current Rating. The Current Rating becomes the input to the next chart in the form of the Internal Rating, thus maintaining the connections in the performance relationships. Completion of the Quality Activity Planning chart causes the performance results to cascade upwards to chart 1 Strategic Requirements Planning, thereby completing the remaining columns of Actual Score, Performance Rating and Current Rating.

The method to follow to complete all the charts is summarised (Figure 5.12) in a flowchart and complemented by an example QAP QFD chart (Figure 5.13). An example of four completed charts with numbers and arrows showing the return process is shown (right hand side of Figure 5.14.)

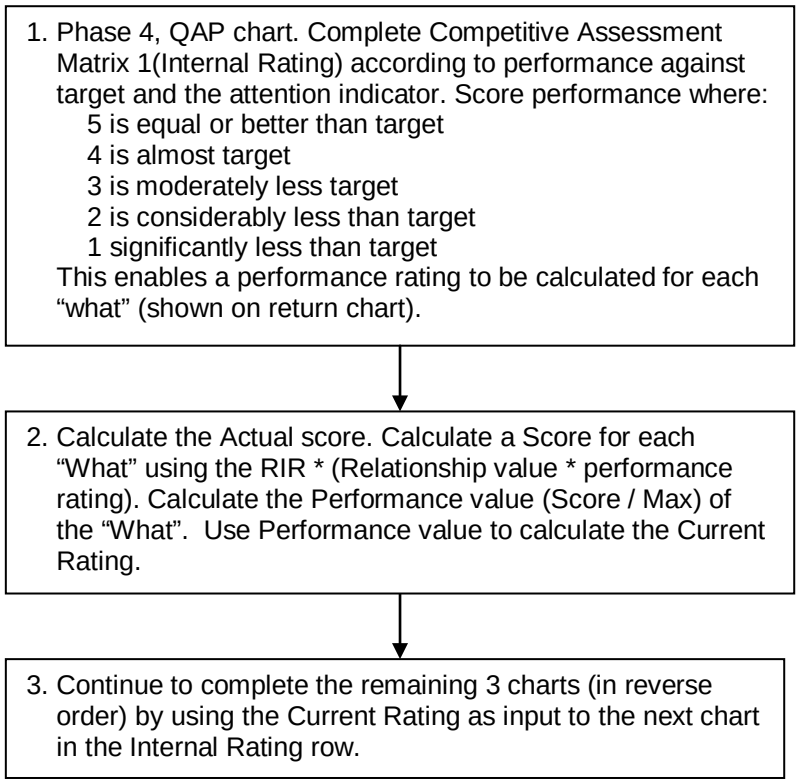
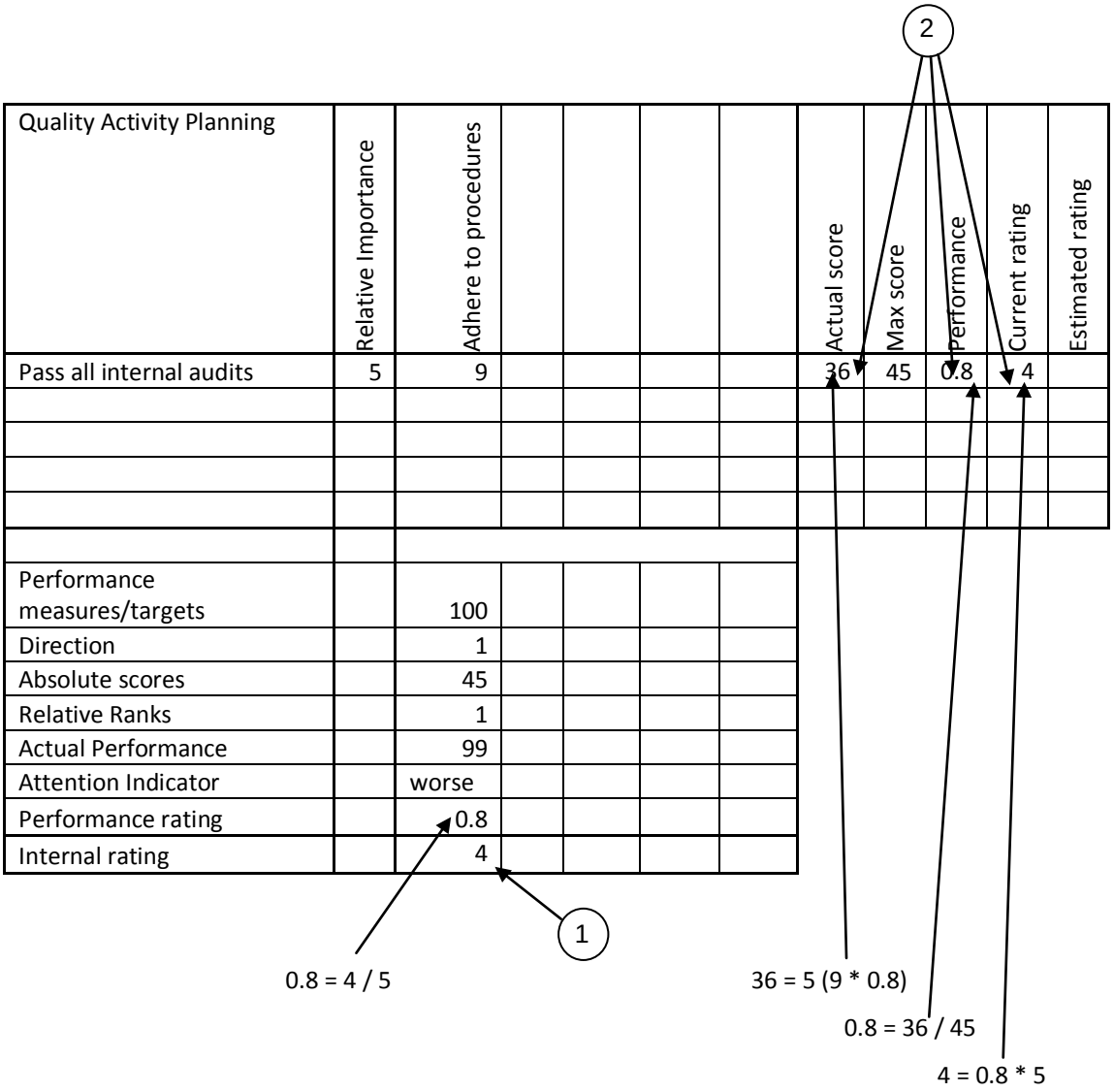


Figure 5.12 Data Feedback – "return": Chart Completion.



Key: Items 1 and 2 correspond to Chart Completion Flowchart (Figure 5.13)

Note Current Rating value becomes input to the next chart in the form of Internal Rating.

Figure 5.13 Adapted Annotated QFD chart – Data Feedback with calculation examples

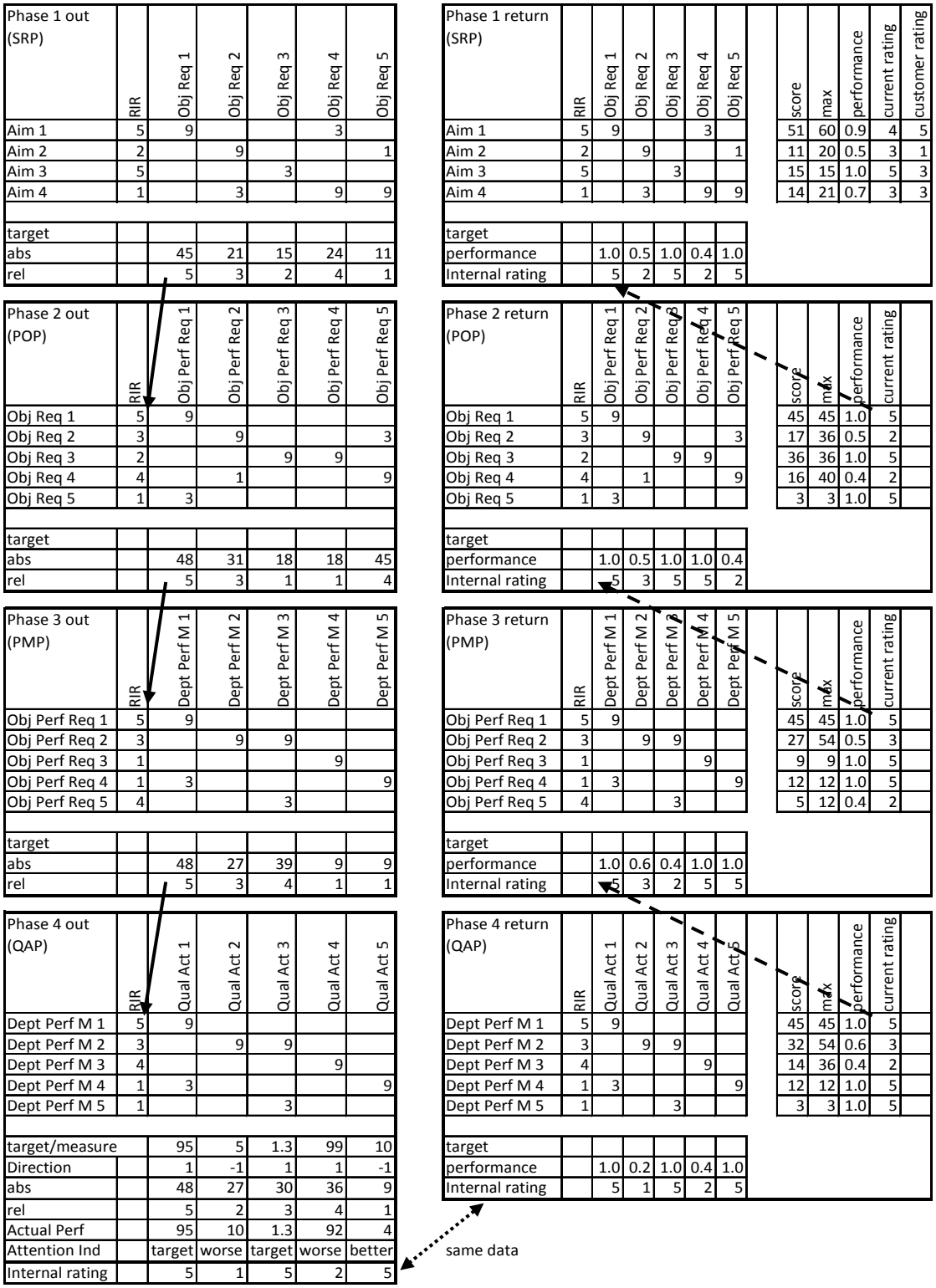


Figure 5.14 Simplified QFD charts: Data to show "Out" and "Return" Linkages

5.4.2.4 Multi Department QFD Chart Completion

The example illustrated in Figure 5.15 demonstrates the QPQAP framework deployed in a single department/product organisations. However, many organisations are more complex, consisting of many departments and/or products, and the QPQAP deployment process can be adapted to accommodate such an organisation structure, as shown in Figure 5.15.

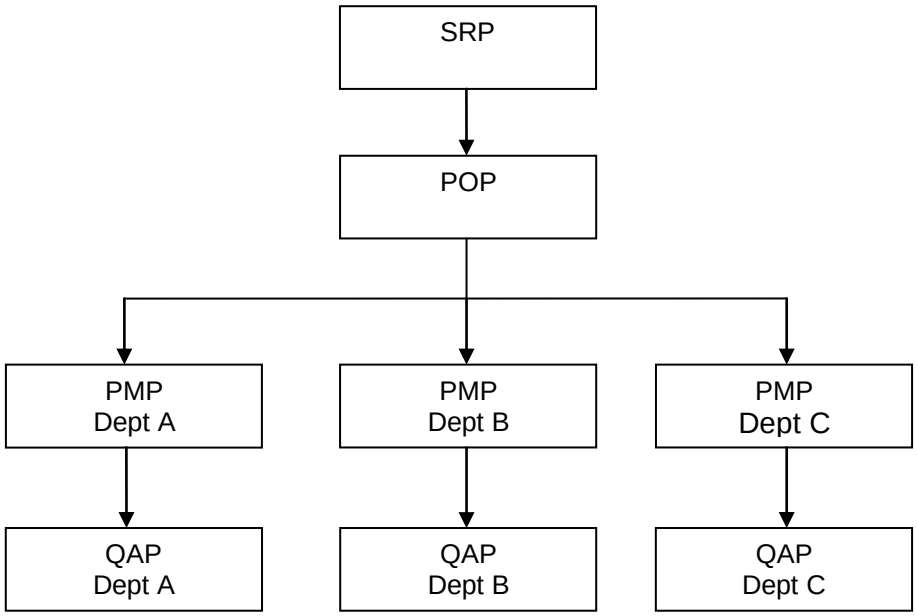


Figure 5.15: Multi Dept QPQAP chart linkages

The data mapping “out” leg of the QFD chart completion remains unchanged with the Objective Performance Requirements (from the POP chart) forming the input to the PMP chart for each dept in the organisation. The feedback and review “return” process is the same for the QAP and PMP charts but the difference is in the incorporation of the many PMP chart Objective Performance Requirements (OPR) performance and current rating scores into the single POP chart internal rating value. This is calculated by determining the weighted value of the input data:

OPR1 = sum {(OPR1A * WA)+(OPR1B * WB) + (OPR1C * WC) …}

Where WA = weight factor dept A
WB = weight factor dept B
WC = weight factor dept C

The weighting factor must be determined by the organisation and can be a different weight for each departments' impact on the objective performance requirement (as shown in Table 5.3).

	Dept A	Dept B	Dept C	Total =1
Objective Performance Requirement 1	0.5	0.3	0.2	1.0
Objective Performance Requirement 2	0.6	0.3	0.1	1.0
Objective Performance Requirement 3	0.7	0.2	0.1	1.0
Objective Performance Requirement 4	0.4	0.4	0.2	1.0
Objective Performance Requirement 5	0.3	0.4	0.3	1.0

Table 5.3: Weighted Factors by department and Objective Performance Requirement

A weighting factor has been incorporated in recognition of the fact that each department will be different and may influence the company performance, objectives and aims to a lesser or greater extent than others. The weight factor may be based on the department sales value, production volume, number of employees or other value considered relevant by the organisation that will impact on each individual objective performance requirement and also reflect the balance between departments. Some quality activities may not be performed in all departments and therefore departments could be zero weighted.

5.5 Chapter Summary

This chapter has taken the QPQAP Framework produced in Chapter 4 and developed a methodology to enable its' deployment. Firstly three potential deployment methods were compared and QFD was found to be the most suitable technique. The chapter then describes how the QFD Chart has been adapted to suit the QPQAP Framework. This is followed by the deployment method to maintain linkages and relationships and ensure that data accurately transfers between charts in both the Data Mapping – Out phase and the Data Feedback – Return phase. Finally the deployment method has also been produced for a multi-department organisation.

The next phase of the research is to examine the QFD charts in order to analyse, test and review them to ensure they are fit for purpose.

6.1 Introduction

This chapter details the analysis and testing that has been undertaken to prove that the QPQAP Framework is fit for purpose. The chapter will start by describing how the QPQAP Framework should be analysed to check the accuracy of the individual QFD charts. Next, the method for analysing the charts together within the scope of the Framework will be presented. This analysis will focus on the Data-Feedback phase, starting with the recording of the Internal Rating value in the QAP chart, and subsequently determining the effect that this value has on the achievement of the strategic quality aims of the organisation. The analysis is designed to ensure that organisations can use the data to answer the questions established previously in the research:

- Which quality activities inhibit the fulfilment of a strategic quality aim and should be investigated/managed to provide the required (or improved) quality performance?

This chapter will then describe the testing of the QPQAP Framework, by following the analysis method, to prove that it works in different data scenarios. The testing will also explore analysis outcomes when erroneous data is entered into the relationship matrix.

6.2 Chart Analysis

It is necessary to analyse the charts from two perspectives: completion accuracy and performance improvement especially with respect to quality activity deployment and the management of the activities to achieve the organisations' strategic quality aim.

6.2.1 Pre-Analysis QFD Chart Checks

The first stage of the analysis process is to validate the accuracy of each of the four charts especially the primary data; the "Whats" "Hows" and relationships. Each chart should be reviewed in turn using the flowchart, Figure 6.1, as a structured approach.

The Pre-Analysis Check flowchart is most useful after the QPQAP Framework has been established some time and the original charts have been updated. When the charts are first created the fundamental errors that this flowchart is checking for should not have occurred as they would indicate a careless approach by the chart owner/completer. The "Whats" and "Hows" are created as part of the cascading of data down through the charts in the Data Mapping – out phase (as detailed in Chapter 5, section 5.4). As an organisation becomes committed to using the charts and starts to use the QPQAP Framework for driving performance and quality activities, then the "Whats" and "Hows" will be amended to reflect

current activities and performance measures, and it is through these updates that errors may unintentionally be incorporated into the charts.

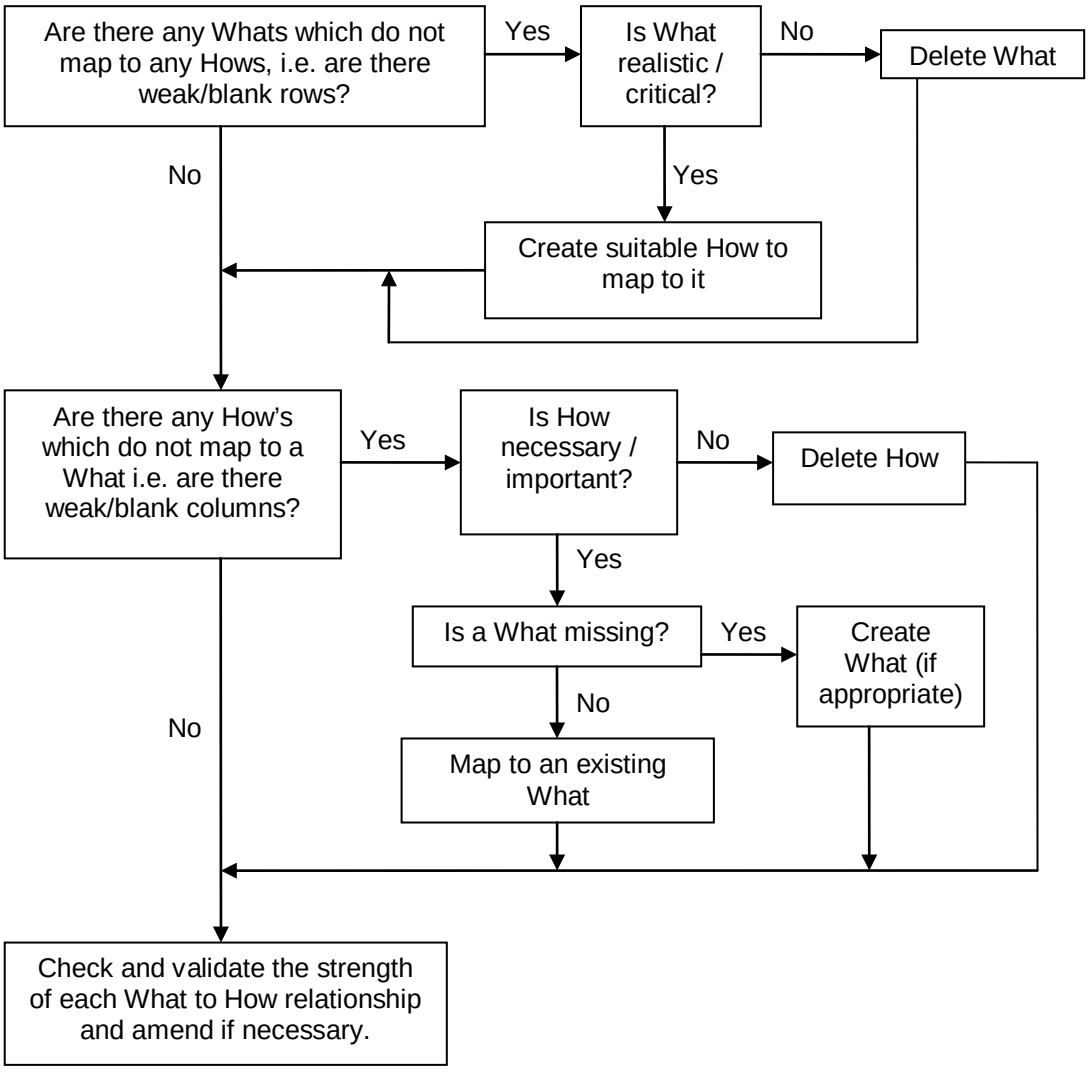


Figure 6.1: Pre-Analysis Checks

Particular attention should be paid to the QAP chart as it is more likely to be changed to reflect changes in quality activities in the search for improvements and therefore more prone to having errors accidentally incorporated. Since the "Hows" are derived from the "Whats" then if a "What" is missing this would normally suggest it has been deleted to reflect changes and evolution in the Framework. Therefore it is more likely a "How" would be deleted or mapped to another "What" rather than create a new "What".

It is critical that the primary data is correct and this relies entirely on the organisations' management and the individuals responsible for each chart. Errors in the primary data will cause the analysis and evaluations to reveal illogical and incorrect outcomes. This will be demonstrated later in this chapter.

6.2.2 QPQAP Framework Chart Analysis

The aim of the QPQAP Framework is to align quality activities with quality strategy to enable organisations to determine whether the quality activities deployed are delivering/meeting expectations. Therefore the analysis must start with the quality activities performance as described in the Quality Activity Planning chart.

Furthermore, it is essential that the chart analysis process is simple, quick and easy to use without being prone to errors. Chart users must be able to make timely decisions based on reliable data.

6.2.2.1 QPQAP Analysis Chart Completion: Single Department

In order to facilitate the analysis process a QPQAP Analysis Chart has been created (Figure 6.2) and completed with data taken from Figures 5.8, 5.9, 5.10 and 5.11 as detailed in Chapter 5, in order to illustrate how it should be completed and as a starting point for the analysis explanation. The purpose of this document is to map the linkages between the underperforming quality activities and the relevant strategic quality aims. The chart will reveal how the linkages and interactions of the relationships affect performance through the Current Rating values as the data is cascaded up through the charts as a consequence of the Data Feedback phase. Mapping out of the linkages related to poor performance will also ensure that should there be any problems or anomalies in the data they will be detected during the analysis stage as this is a summary process which will provide the opportunity for organisations to review and interpret the data.

In order to complete the QPQAP Analysis Chart it has been annotated (Figure 6.2) to facilitate the compilation process. Along the top of the chart are a series of annotations which indicate the type of data to be entered into each box. At the bottom of the chart the series of brackets are used to indicate which of the four QFD charts should be reviewed in order to obtain the appropriate data. For example, to link an Objective Performance Requirement to an Objective Requirement then the Performance Objective Planning (POP) chart should be analysed. Finally it should be noted that as many data entry rows as required can be added to the chart – it has been limited to three for clarity purposes. A comments column has been included in order to record any pertinent information that may affect the linkages, performance values or categories across a row, particularly if this knowledge could influence the subsequent analysis, results and decisions made.

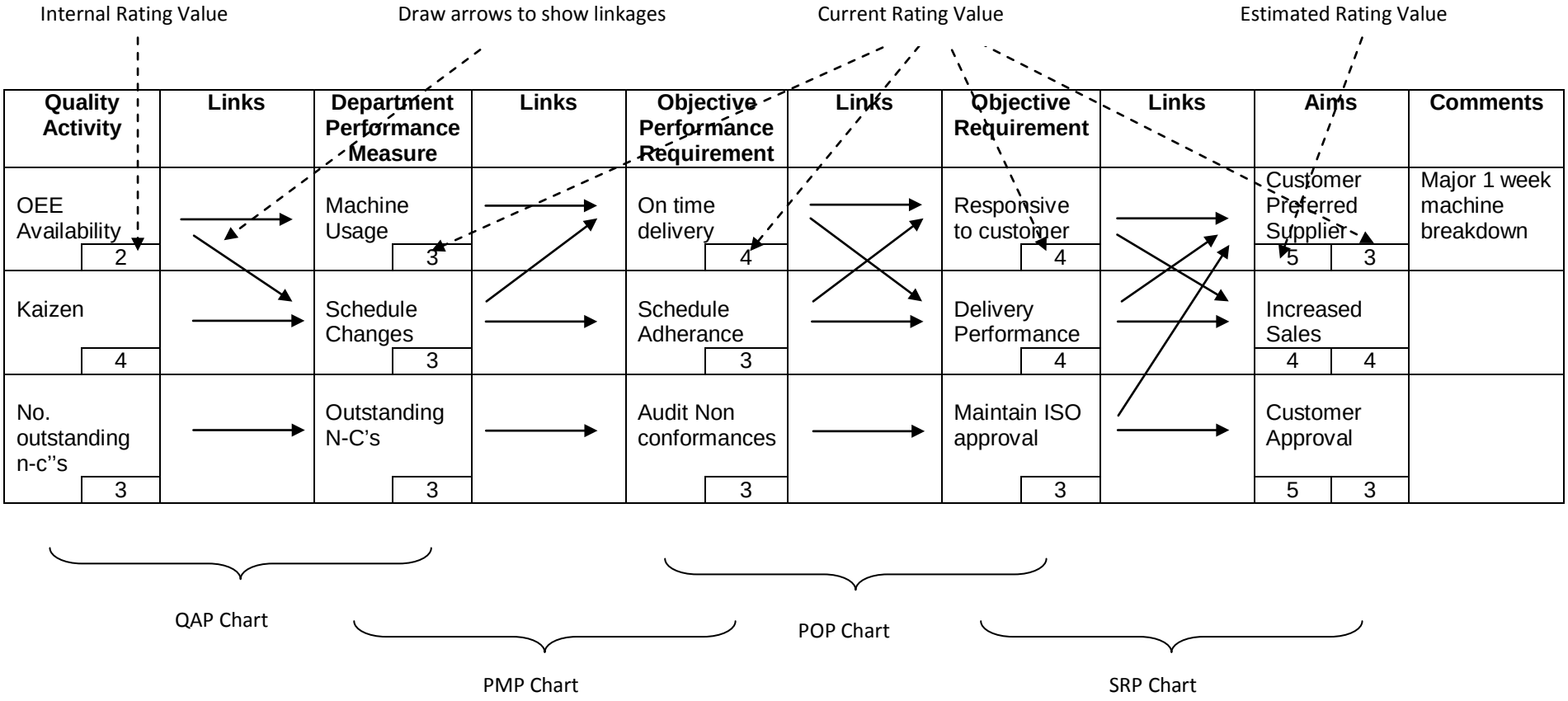


Figure 6.2 QPQAP Example Analysis Chart: Annotated to aid completion

To complete the QPQAP Analysis Chart:

1. Review the QAP chart, identify the poorest performing Quality Activities (the ones with the lowest Internal Rating (IR)) and enter this information in the first column. Then analyse the chart to determine which Department Performance Measure(s) it maps to and its' Current Rating value, and enter this data on to the chart. Draw arrows to show the linkages. A number of Quality Activities may map to one Department Performance Measure and affect the associated Current Rating value. At this stage the evaluator should notice the strength of the relationships, in order to establish which of the Quality Activities Internal Rating values are having the greatest impact. Alternatively a Quality Activity may affect a number of Department Performance Measures, again the relationship strength should be observed to determine the greatest impacts. If there are too many links then only those with the strongest relationships and therefore the greatest impact should be mapped. This will prevent the charts becoming over complex and enable organisations to focus on the vital few activities which will have the most significant impact.
2. Next the PMP chart should be reviewed, by assessing the Department Performance Measures already identified on the chart and identifying the Objective Performance Requirements to which they map. The Objective Performance Requirement and it's Current Rating should be documented on the chart, along with the arrows to map the linkages. There may be a variety of linkages between the Department Performance Measures and the Objective Performance Requirements; however the evaluator should observe where the poor Current Rating values are being transmitted through the Framework on the document (due to the stronger relationships).
3. The next step is to review the POP chart. Each of the identified Objective Performance Requirements should be examined and through the POP chart, linked to Objective Requirement(s). This should be documented on the QPQAP Analysis chart, along with arrows to show the linkages and the Current Rating value. An Objective Performance Requirement may map to one or more Objective Requirements. The evaluator should monitor the Current Rating values and look for changes.
4. The final step is to examine the SRP chart and link the Objective Requirements to the Aims, documenting this and the Current Rating on the chart as before. In addition the evaluator should add the Estimated Rating Value and make a note of any pertinent issues that could affect the performance of the quality activity in the comments box. The evaluator should also assess the final Current Rating values, compare these to the Estimated Rating values and look for discrepancies, as well as reviewing how the Current Rating values have linked/cascaded through the chart.

During the completion of the chart the evaluator will be deepening their knowledge about the data as an informal precursor to the formal final analysis stage. In particular the Current

Rating values may increase or decrease as they have cascaded through the chart and have potentially been affected (particularly positively) through items that are not documented on the Analysis Chart. This knowledge will facilitate the formal chart analysis phase and in addition the evaluator may suspect or detect relationship errors due to a logical and detailed approach indicating problems.

6.2.2.2. QPQAP Analysis Chart Completion: Multi Department

In order to complete the analysis chart in a multi department organisation, the completion phase needs to be split into two stages in recognition of the fact that each department has an individual QAP and PMP chart which feeds into the company wide POP chart, as illustrated in Chapter 5 (Figure 5.16). Although the same format of the QPQAP Analysis Chart should be used it may need more rows on which to record the increased amount of data. These two stages have been illustrated (Figure 6.3) and are:

1. Stage 1. Review the QAP chart and PMP chart for Department A, and complete the QPQAP Analysis chart in line with the descriptions presented in the previous section. Next review the QAP and PMP charts for Department B, and complete the QPQAP Analysis Chart accordingly. Continue in this manner until all departments QAP and PMP charts have been reviewed. It may be noticed that as the PMP charts are reviewed there may be commonality amongst the underperforming Objective Performance Requirements, and Department Performance Measures from across each of the departments may link to the same one. There could be many Department Performance Measures linking to just a few Objective Performance Requirements and due diligence should be taken.
2. Stage 2. Review the POP and SRP charts and complete by following the instructions described previously for a single department organisation. During this stage the organisations' overall performance becomes apparent as the linkages become simpler and the effects of Current Rating values for the Objective Performance Requirements are amalgamated from the multiple departments. The departments with the largest impact have a greater influence on the Current Ratings as the data cascades through the final two charts.

6.2.2.3. QPQAP Analysis Chart Evaluation

The chart evaluation process does not vary between single department and multi department organisations. However thoroughness is required when evaluating an analysis chart from a multi department organisation because the linkages and relationships will probably be more complex between the Department Performance Measures and the Objective Performance Requirements.

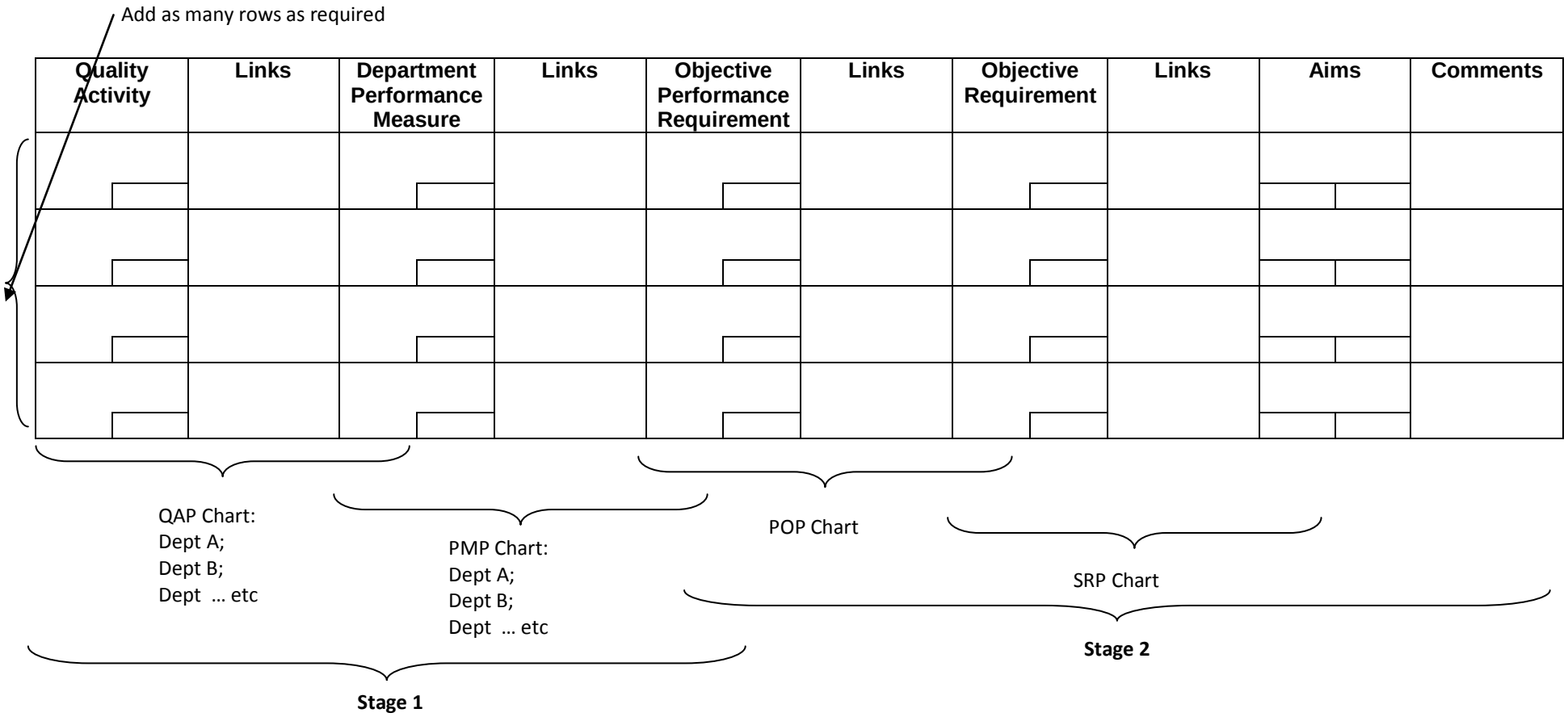


Figure 6.3 QPQAP Analysis Chart: Annotated to aid completion in multi department organisations

In order to explain how to evaluate the QPQAP Analysis chart, the completed Analysis Chart (Figure 6.2) can be used as an example, and read in conjunction with the four questions stated below. The QPQAP Analysis Chart should be reviewed holistically, with a view to answering the questions:

1. Which quality activity(ies) have the most detrimental effect on the quality aims?
   In order to answer this question the chart should be read from left to right, the links tracked though the chart and the Current Rating values assessed as the linkages are traced from left to right. The Current Rating values indicate how the effect of the poor performance (shown in the low Internal Rating) may change as it travels through the charts.

2. Which Aims have Current Rating values that indicate they are underperforming, and can be tracked back to establish the Quality Activity responsible for this underperformance?
   The chart should be read from right to left, the linkages followed and the Current Rating values assessed to follow the track of the poorest performance and reveal the quality activity(ies) having the most detrimental effect.

3. Which of the worst performing Aims have an Estimated Rating higher than the Current Rating?
   This indicates that there is a problem concerning the perception of the aims' performance and its actual performance, that is, the organisation is not fulfilling its aim as well as it perceives it to be. The mismatch requires investigation to determine whether the Estimated Rating value is reliable (for example customer based) and therefore suggesting a potential problem with the quality activities being used or the existing quality activities relationships. Alternatively the Estimated Rating value may be adjusted if the company has over estimated its' own performance.

4. Based on the answers to the above questions, which quality activity(ies) requires attention and possible further investigation? What is the priority order for action?
   This question should be answered by taking a holistic view to the answers to the previous questions – if the charts have been completed accurately and reliably then the answers should be consistent, in agreement and provide a very clear indication of the quality activity(ies) to be focussed upon.

These questions as previously stated have been used to evaluate the Analysis Chart (Figure 6.2) as it provides an example of the key underperforming quality activities and the effect that they have on an organisations' strategic quality aims. The logic/answers to the questions are documented (Figure 6.4) in order to provide an example of a "typical evaluation".

1. **Which quality activity(ies) have the most detrimental effect on the quality aims?**
   The effect of OEE Availability Internal Rating (IR) 2 gradually minimises through the charts, and in the POP chart has translated into a Current Rating (CR) of 4, although this reduces to a CR of 3 in the SRP chart for the Aim of Customer Preferred Supplier.
   Outstanding Non-conformances (3) maintains this level of impact on performance as it is tracked through the charts to the SRP chart with an impact on Customer Approvals and Customer Preferred Supplier, both with CR ratings of 3.
2. **Which Aims have a Current Value Rating which indicates they are underperforming, and can be tracked back to establish which Quality Activity is responsible for this underperformance?**
   Customer Preferred Supplier tracks back to OEE Availability, Kaizen and Outstanding N-C's. Customer Approvals traces back to Outstanding N-C's.
3. **Which Aims have an Estimated Value Rating higher than the Current Value Rating?**
   Customer Preferred Supplier and Customer Approvals
4. **Which quality activity(ies) requires attention and possible further investigation? What is the priority order for action?**
   Outstanding Audit N-C's should be first priority as they impact two aims: Customer Preferred Supplier and Customer Approval. It is likely, based on the linkages and Current Rating values in the Analysis chart, that improvements in the performance of this activity will have a positive impact on both aims even if the performance of OEE Availability remains the same.
   OEE Availability should be second priority. The Analysis chart indicates the poor performance in this activity is mediated by other activities and interactions as it is traced through the charts and therefore improvements may not have a significant affect. Also the comments column suggests that the poor performance may have been caused by one factor, permanent resolution of which may improve the long term performance.

Figure 6.4 Example Outcomes from Evaluation of QPQAP Analysis Chart

6.2.3 Evaluation Outcomes

The outcome of the QPQAP Analysis Chart evaluation is a list of quality activities, in priority order, which require further attention in order to improve their performance. It is at this point where an organisation may be faced with questions such as:

- Why is this quality activity underperforming?
- What is the root cause of this performance?
- What can be done to address this under performance?
- Why are the results not reflecting the effort that is being made in this activity?

In order to answer these questions fully the organisation may need further information about what is actually happening in terms of the specific quality activities individuals are engaged in and the associated performance measures. There is a need for evidence in order to answer these questions and on which to base changes to the way quality activities are operationalised. The changes to the activities at an operational level in the organisation can be called interventions. Interventions should be made in response to the poor performance of a quality activity and the information obtained from any subsequent investigations.

Once interventions have been made a time “lag” is required, whilst the effects of the interventions take affect. The nature of the quality activity and the intervention will determine the length of time of this “lag”. The organisation is in the best position to assess the length of time involved. Once sufficient time has elapsed then the QPQAP Framework charts should be modified to reflect the latest performance of the quality activities and the Internal Rating amended as appropriate, and once this effect has cascaded up through the charts, the analysis phase can be started again. This is an iterative and continuous process as illustrated in Figure 6.5.

By taking the example QFD charts (presented in Chapter 5) and the QPQAP Analysis Chart (Figure 6.2) and assuming an intervention then the iterative process (Figure 6.5) can be demonstrated.

Using the analysis presented, Figure 6.4, it was shown that the quality activity needing attention was Outstanding Audit Non-conformances. It is assumed that an intervention has been made, which over a period of time has had a positive effect on the performance of this quality activity, so that the QAP chart can be modified, and the results of this change cascaded up through the charts. These modifications are shown (Figure 6.6) highlighted, cascading up through the charts, from the QAP chart, to PMP, to POP and finally to SRP. The next step is to start over, as illustrated (Figure 6.5) and analyse the QPQAP Framework by completing another Analysis Chart to determine the next quality activity that should be priority for attention.

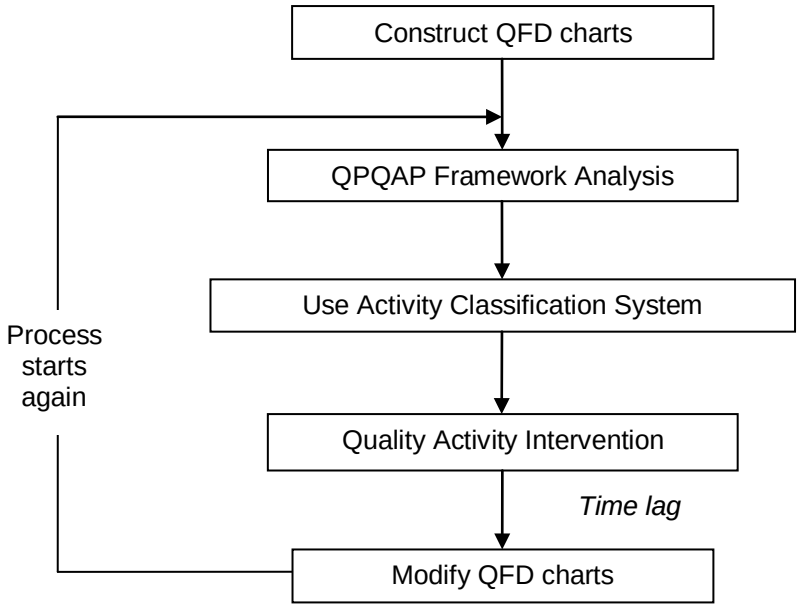


Figure 6.5 Iterative Process – completion and analysis

Strategy Requirements Planning	Relative Importance	Maintain ISO9001	Responsive to customer	Product performance (quality)	Delivery Performance	Cost reduction	Actual score	Max score	Performance	Current Rating	Estimated rating
Maintain Customer Approvals	3	9		3			36	36	1.0	5	5
Customer Preferred Supplier	4	3	9		9		70	84	0.8	4	5
Increased Sales	3		3	9	3		41	45	0.9	5	3
Increased profit	5					9	45	45	1.0	5	3
Performance Measures/Targets		Zero audit N-C's	Within 24 hours	Warranty returns	Ontime, In full	Savings £					
Absolute scores		39	45	36	45	45					
Relative Ranks		2	3	1	3	3					
Performance rating		1.0	0.8	1.0	0.8	1.0					
Internal rating		5	4	5	4	5					

Performance Objective Planning	Relative Importance	Audit Non conformances	On time delivery	Cost of quality	Concessions/waivers	Schedule adherance	score	max	performance	current rating	estimated rating
Maintain ISO9001	2	9					18	18	1.0	5	
Responsive to customer	3		9			3	28	36	0.8	4	
Product performance (quality)	1			9	9		18	18	1.0	5	
Delivery Performance	3		9			3	28	36	0.8	4	
Cost reduction	3			9	3		36	36	1.0	5	
Performance Measures/Targets		Zero major N-C's	100% on time	< £2k per month	< 5 per month	100% adherance					
Absolute score		18	54	36	18	18					
Relative Ranks		1	5	4	1	1					
Performance Rating		1.0	0.8	1.0	1.0	0.7					
Internal rating		5	4	5	5	3					

Performance Measurement Planning	Relative Importance	Outstanding audit n-c's	Machine usage	Right first time	Scrap Costs	Schedule changes	score	max	performance	current rating	estimated rating
Audit Non conformances	1	9					9	9	1.0	5	
On time delivery	5		9	9		1	75	95	0.8	4	
Cost of quality	4	3		9	9		84	84	1.0	5	
Concessions/waivers	1	1		3	1		5	5	1.0	5	
Schedule adherance	1		9	3		9	14	21	0.7	3	
Performance Measures/Targets		zero outstanding	90% machine untilisation	95% RFT	% reduction	zero changes					
Absolute Score		22	54	87	37	14					
Relative Ranks		2	4	5	3	1					
Performance Rating		1.0	0.6	1.0	1.0	0.6					
Internal rating		5	3	5	5	3					

Quality Activity Planning	Relative Importance	no outstanding n-cs	Statistical Process Control	OEE Availability rate (TPM)	% pass inspection and test	Kaizen activity changes/mth	Actual score	Max score	Performance	Current rating	Estimated rating
Outstanding audit n-c's	2	9					18	18	1.0	5	
Machine usage	4			9	3		26	48	0.6	3	
Right first time	5		9		9		90	90	1.0	5	
Scrap Costs	3		9		9		54	54	1.0	5	
Schedule changes	1			9		9	11	18	0.6	3	
Performance measures/targets		0	1.33	85	98	0					
Direction		-1	1	1	1	-1					
Absolute scores		18	72	45	84	9					
Relative Ranks		2	4	3	5	1					
Actual Performance		0	1.5	80.0	99	5					
Attention Indicator		target	better	worse	better	worse					
Performance rating		1.0	1.0	0.4	1.0	0.8					
Internal rating		5	5	2	5	4					

Figure 6.6 Modified QPQAP Framework after positive intervention

The QAP chart is the key component of the QPQAP Framework since the documented quality activities, Internal Rating Values and subsequent interventions (which are possibly quality activities) drive the Data Feedback – return phase and Chart Analysis process. Therefore it is critical that the data used to generate this information is rigorous and reliable.

Although the QPQAP Framework has been developed in order to manage underperforming quality activities with a view to achieving long term ongoing continuous improvement, it is recognised that organisations could use the framework differently. The Framework can be used to make decisions concerning "trade-offs", for example, where resources are limited and optimum performance gains can be achieved for minimum effort. Alternatively impacts of performance changes can be evaluated so that any consequences in changes to resources can be minimised.

6.3 QPQAP Framework Testing

The purpose of the QPQAP Framework testing is twofold; firstly it is necessary to demonstrate that it fulfils its objectives, that it links quality activities to an organisations strategic quality aim through performance measurement and management and that changes in quality activities performance can alter the organisations performance against its' strategic aims; secondly the testing will prove the analysis methodology described in the previous section of this chapter and that the Analysis Charts provide the correct solutions.

In order to test the framework, both theoretical and "actual" testing was considered. However, it was concluded in the Research Methodology (Chapter 3) that theoretical testing would be sufficient to prove the QPQAP Framework in a generic sense. Organisations were approached by the author in order to obtain real data to populate and test the framework. However, performance data is considered commercially sensitive and the organisations would not release this type of information. Also, it was found that organisations were not prepared to reveal the precise nature of all their quality activities or how these were measured (if at all).

Therefore dummy charts, populated with illustrative example data have been generated in order to test the QPQAP Framework. The charts have been created to reflect two main scenarios; charts completed correctly and charts completed incorrectly; in order to determine the effect of these opposing scenarios on the success (or otherwise) of the Framework.

Within these two main scenarios a range of "situations" have been created in order to reflect extreme and normal conditions to which the QPQAP Framework could be exposed. The purpose of these situations is to establish whether changes in quality activity performance do

cascade up through the charts and still affect performance against the organisation's strategic quality aims. The testing process will be conducted for the single department and multi department QPQAP Frameworks.

6.3.1 Testing: Situations and Scenarios

A variety of situations have been considered in order to reflect possible "real life" companies.

The situations for consideration are:

1. All Quality Activities are underperforming. It is intended that the QPQAP Framework enables organisations to manage their quality performance. In the section on Chart Completion (Chapter 5) it was advised that performance targets were set that are realistic and achievable. If a company is under performing across all targets then it is suggested that the targets are too ambitious and should be adjusted. The consequences of having all quality activities underperforming will be considered alongside the test results for this situation.
2. All quality activities are over performing or at target and therefore have a maximum internal rating value. Although a "one-off" achievement of performance is commendable and desirable, the aim of the QPQAP Framework is to facilitate and manage performance improvement. Therefore performance targets/measures should be reviewed for accuracy and validity. If the organisation is genuinely meeting all targets and the Estimated Rating is reliably the same as the Current Rating then the frequency of review for the QPQAP framework can be reduced. However if a difference exists between these values then investigation is required as it is likely that in completing the SRP chart a "how" may have been missed/overlooked.
3. One quality activity is over performing or at target and the others are underperforming is a potential situation and can be used to test the QPQAP Framework. It is likely that this situation may occur when an organisation first starts to use the framework and has set demanding targets and has just missed achieving some of them (as quality improvement is still in its infancy at the company and the quality activities' performance can be erratic). It is essential that this satisfactory activity's effect is not "lost" in amongst the underperforming items.
4. One activity is underperforming. An organisation may find itself in this situation after it has been improving quality and is facing the more difficult improvements to make. It is critical that the framework and analysis identifies this activity as needing attention and any effects/consequences of its underperformance are cascaded accurately through the QPQAP framework.

There is a state between 3 and 4 where a number of activities may be performing/target or underperforming. But this quantity is unknown as it will vary between organisations and therefore difficult to predict. However situations 3 and 4 are the extremes and therefore the focus for the testing.

In order to evaluate the scenario concerning the impact of having an incorrect relationship it was decided to adjust the relationships in the QAP chart to create an error (false relationship). The QAP chart is more likely to be amended by the organisation as the quality activities are changed in order to improve the performance of the Department Performance Measure (DPM) as this is the purpose of the QPQAP Framework. The "Whats" and "Hows" in the other charts are relatively static and would only be updated following a review of the organisations strategic quality aims which resulted in changes being cascaded down through the QPQAP Framework. Therefore it is logical to create scenarios consisting of false relationships in the QAP chart.

6.3.2 Testing: Single Department

A set of charts for SRP, POP, PMP and QAP were produced using illustrative data. For the purpose of single department testing the relationship complexity was reasonably detailed in order to put the framework through its paces. Too simple relationships would not necessarily be an accurate reflection of the framework or "real life". The QAP chart has subsequently been manipulated in order to reflect each of the situations under test.

6.3.2.1 Situation 1: All quality activities underperforming.

Scenario 1: Chart Correct.

Each of the quality activities are not achieving their performance target/measure (Figure 6.7, Quality Activity Planning chart) which is reflected in the low Internal Rating values and the Current Rating values cascaded through the other charts. The quality activities were given different low Internal Rating values as this was considered the most realistic.

Strategy Requirements Planning	Relative Importance	Obj Req 1	Obj Req 2	Obj Req 3	Obj Req 4	Obj Req 5	Actual score	Max score	Performance	Current Rating	Estimated rating
Aim 1	3	9		3			23	36	0.6	3	3
Aim 2	4		9		3		28	48	0.6	3	3
Aim 3	3		3	9	3		31	45	0.7	3	3
Aim 4	5					9	35	45	0.8	4	3
Performance Measures/Targets		95	90	90	99	95					
Absolute scores		27	45	36	21	45					
Relative Ranks		2	4	3	1	4					
Performance rating		0.6	0.6	0.8	0.6	0.8					
Internal rating		3	3	4	3	4					

Performance Objective Planning	Relative Importance	Obj Perf Req 1	Obj Perf Req 2	Obj Perf Req 3	Obj Perf Req 4	Obj Perf Req 5	score	max	performance	current rating	estimated rating
Obj Req 1	2	9					11	18	0.6	3	
Obj Req 2	4		3			9	27	48	0.6	3	
Obj Req 3	3			9	9		41	54	0.8	4	
Obj Req 4	1		9			3	7	12	0.6	3	
Obj Req 5	4			9	3		37	48	0.8	4	
Performance Measures/Targets		90	90	95	99	99					
Absolute score		18	21	63	39	39					
Relative Ranks		1	2	5	3	3					
Performance Rating		0.6	0.6	0.8	0.8	0.5					
Internal rating		3	3	4	4	3					

Performance Measurement Planning	Relative Importance	Dept Perf M1	Dept Perf M2	Dept Perf M3	Dept Perf M4	Dept Perf M5	score	max	performance	current rating	estimated rating
Obj Perf Req 1	1	9					5	9	0.6	3	
Obj Perf Req 2	2		9	9		1	24	38	0.6	3	
Obj Perf Req 3	5	3		9	9		81	105	0.8	4	
Obj Perf Req 4	3	1		3	1		11	15	0.8	4	
Obj Perf Req 5	3		9	3		9	34	63	0.5	3	
Performance Measures/Targets		90	95	99	95	90					
Absolute Score		27	45	81	48	29					
Relative Ranks		1	3	5	4	2					
Performance Rating		0.6	0.5	0.8	0.8	0.5					
Internal rating		3	3	4	4	3					

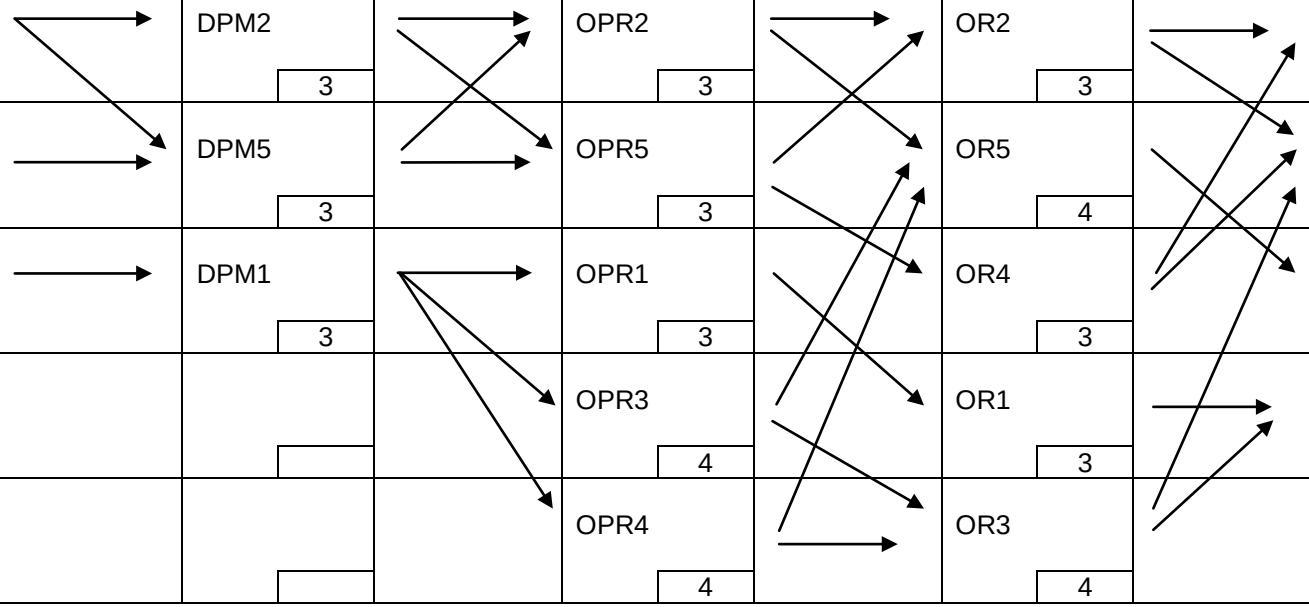
Quality Activity Planning	Relative Importance	Qual Act 1	Qual Act 2	Qual Act 3	Qual Act 4	Qual Act 5	Actual score	Max score	Performance	Current rating	Estimated rating
Dept Perf M1	1	9					5	9	0.6	3	
Dept Perf M2	3			9	3		18	36	0.5	3	
Dept Perf M3	5		9		9		72	90	0.8	4	
Dept Perf M4	4		9		9		58	72	0.8	4	
Dept Perf M5	2			9		9	18	36	0.5	3	
Performance measures/targets		0	99	90	95	5					
Direction		-1	1	1	1	-1					
Absolute scores		9	81	45	90	18					
Relative Ranks		1	4	3	5	2					
Actual Performance		3	98	80	94	7					
Attention Indicator		worse	worse	worse	worse	worse					
Performance rating		0.6	0.8	0.4	0.8	0.6					
Internal rating		3	4	2	4	3					

Figure 6.7 QPQAP Framework: all activities underperforming, relationships correct

If they were all the same then the Aim's Current Ratings (illustrated on the SRP Chart) would also be the same and this would not be a genuine test of the framework. QA3 was selected to have the lowest Internal Rating based on its relationship with two Department Performance Measures and one of these relationships being moderate was considered a more challenging test as it is less likely to demonstrate changes. Chart Analysis (Figure 6.8) has been evaluated (note that only the worst performing activities were included in order to focus on those with greatest opportunity for improvement) and quality activities QA1, QA3 and QA5 should be prioritised as they impact Aims 1, 2 and 3. This demonstrates the problem with having all activities underperforming as it is difficult to differentiate where action is required, particularly if resources are limited. There is no clear focus. This emphasises the need to ensure that targets are SMART when the chart is originally completed, but also for genuine situations there is a need to develop a method of prioritizing actions.

The Estimated Ratings and the Current Ratings in the SRP chart should be noted and where these are the same (for example Aims 1, 2 and 3) then the organisations perception of its performance aligns with actual performance indicating a good understanding. Note that the Aim 4 Estimated rating is lower than the current rating since it has been based on the company's perception of performance. However, it should be changed to be the same as the Current Rating given that there is confidence in the chart being correct.

Quality Activity	Links	Department Performance Measure	Links	Objective Performance Requirement	Links	Objective Requirement	Links	Aims	Comments
QA3 2		DPM2 3		OPR2 3		OR2 3		A2 3 3	
QA5 3		DPM5 3		OPR5 3		OR5 4		A3 3 3	
QA1 3		DPM1 3		OPR1 3		OR4 3		A4 3 4	
				OPR3 4		OR1 3		A1 3 3	
				OPR4 4		OR3 4			



1. Forward analysis links QA3 and QA5 to lowest performing A2 and A3, and QA1 links to A1.
2. Backward pass analysis links A1 to QA1 and A2 and A3 to both QA3 and QA5.
3. A4 has Estimated Rating values lower than Current Rating so further investigation required.
4. Prioritise QA1 to improve A1 and QA3 due to lowest IR value.

Figure 6.8 QPQAP Analysis Chart and Analysis Comments

Scenario 2 Chart Incorrect

In order to determine the effect of an incorrect relationship, it was found that by changing the strength of the relationship between QA3 and DPM2 from 9 to 1 (Figure 6.9), a number of the Current Rating values increased (Figure 6.10) producing a false positive effect particularly upon Aim 3.

Strategy Requirements Planning	Relative Importance	Obj Req 1	Obj Req 2	Obj Req 3	Obj Req 4	Obj Req 5	Actual score	Max score	Performance	Current Rating	Estimated rating
Aim 1	3	9		3			23	36	0.6	3	5
Aim 2	4		9		3		32	48	0.7	3	5
Aim 3	3		3	9	3		33	45	0.7	4	3
Aim 4	5					9	35	45	0.8	4	3
Performance Measures/Targets		95	90	90	99	95					
Absolute scores		27	45	36	21	45					
Relative Ranks		2	4	3	1	4					
Performance rating		0.6	0.7	0.8	0.7	0.8					
Internal rating		3	3	4	4	4					

Performance Objective Planning	Relative Importance	Obj Perf Req 1	Obj Perf Req 2	Obj Perf Req 3	Obj Perf Req 4	Obj Perf Req 5	score	max	performance	current rating	estimated rating
Obj Req 1	2	9					11	18	0.6	3	
Obj Req 2	4		3			9	31	48	0.7	3	
Obj Req 3	3			9	9		41	54	0.8	4	
Obj Req 4	1		9			3	9	12	0.7	4	
Obj Req 5	4			9	3		37	48	0.8	4	
Performance Measures/Targets		90	90	95	99	99					
Absolute score		18	21	63	39	39					
Relative Ranks		1	2	5	3	3					
Performance Rating		0.6	0.7	0.8	0.8	0.6					
Internal rating		3	4	4	4	3					

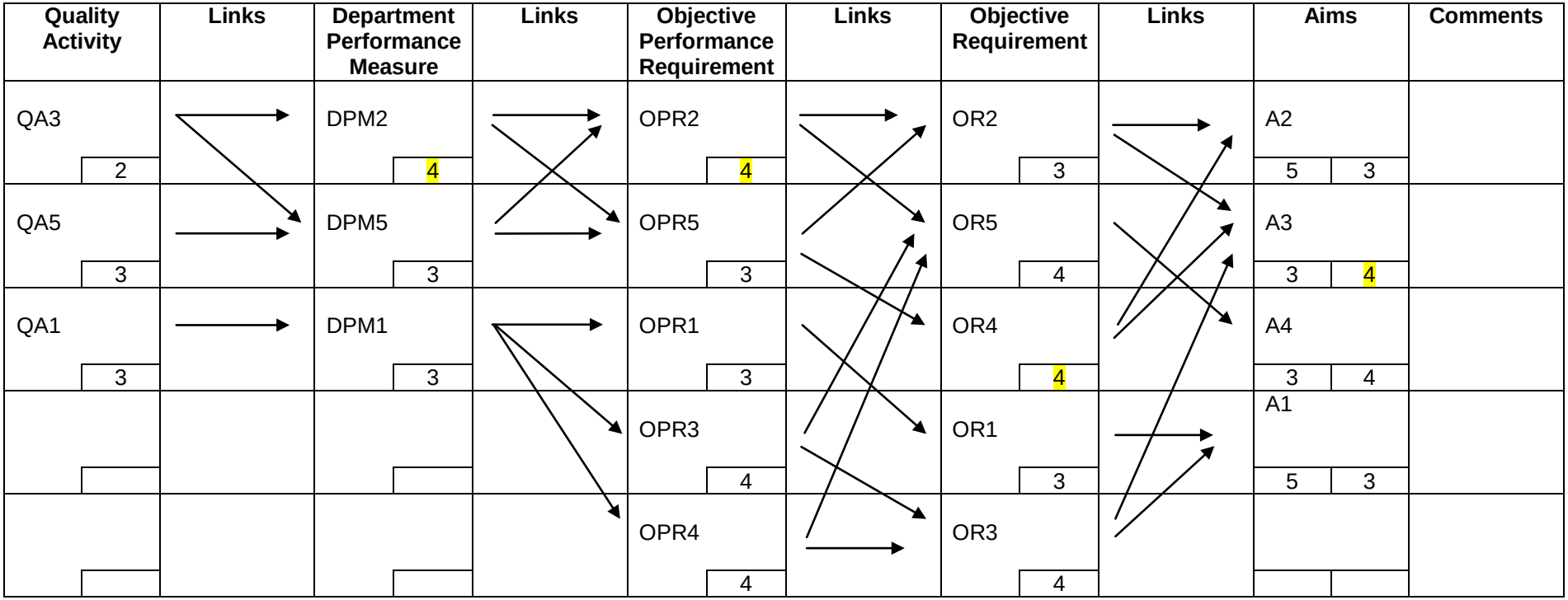
Performance Measurement Planning	Relative Importance	Dept Perf M1	Dept Perf M2	Dept Perf M3	Dept Perf M4	Dept Perf M5	score	max	performance	current rating	estimated rating
Obj Perf Req 1	1	9					5	9	0.6	3	
Obj Perf Req 2	2		9	9		1	28	38	0.7	4	
Obj Perf Req 3	5	3		9	9		81	105	0.8	4	
Obj Perf Req 4	3	1		3	1		11	15	0.8	4	
Obj Perf Req 5	3		9	3		9	40	63	0.6	3	
Performance Measures/Targets		90	95	99	95	90					
Absolute Score		27	45	81	48	29					
Relative Ranks		1	3	5	4	2					
Performance Rating		0.6	0.7	0.8	0.8	0.5					
Internal rating		3	4	4	4	3					

Quality Activity Planning	Relative Importance	Qual Act 1	Qual Act 2	Qual Act 3	Qual Act 4	Qual Act 5	Actual score	Max score	Performance	Current rating	Estimated rating
Dept Perf M1	1	9					5	9	0.6	3	
Dept Perf M2	3			1	3		8	12	0.7	4	
Dept Perf M3	5		9		9		72	90	0.8	4	
Dept Perf M4	4		9		9		58	72	0.8	4	
Dept Perf M5	2			9		9	18	36	0.5	3	
Performance measures/targets		0	99	90	95	5					
Direction		-1	1	1	1	-1					
Absolute scores		9	81	21	90	18					
Relative Ranks		1	4	3	5	2					
Actual Performance		3	98	80.0	94	7					
Attention Indicator		worse	worse	worse	worse	worse					
Performance rating		0.6	0.8	0.4	0.8	0.6					
Internal rating		3	4	2	4	3					

Figure 6.9 QPQAP Framework: all activities underperforming, relationship incorrect

The Analysis Chart shows that the organisation is achieving Aim 3 better than perceived with a Current Rating higher than the Estimated Rating, whilst Aims 1 and 2 both have Estimated Ratings higher than the Current Ratings which indicates the company (or customer) believes it is performing better than the framework is indicating. These differences require further investigation to determine the cause of this mismatch and establish the accurate perspective. If the Estimated Rating is based on a customer perception or the organisation has strong evidence to support that it is correct, this would indicate the Current Rating is incorrect and the cause of this anomaly should be investigated, with a closer examination of the “What” to “How” translations and their associated relationships. The low Current Rating should be considered as incorrect and not addressed through improvements via quality activity interventions but rather through amending the “What” to “How” translations or relationships. The mismatch with the Current Rating and Estimated Rating for Aims 3 and 4 suggesting that the organisation is performing better than it has estimated. Again investigations are required to determine which is correct.

Quality Activity	Links	Department Performance Measure	Links	Objective Performance Requirement	Links	Objective Requirement	Links	Aims	Comments
QA3 2		DPM2 4		OPR2 4		OR2 3		A2 5 3	
QA5 3		DPM5 3		OPR5 3		OR5 4		A3 3 4	
QA1 3		DPM1 3		OPR1 3		OR4 4		A4 3 4	
				OPR3 4		OR1 3		A1 5 3	
				OPR4 4		OR3 4			



1. Forward analysis shows strongest effects linking QA1 to A1 and QA3 to A2.
2. Backward pass analysis, following strongest effects links A1 to QA1 and A2 to both QA3 and QA5.
3. A1 and A2 should be investigated further due to significant mismatch in Estimated Rating and Current Rating values and poor performance against these aims.
4. Prioritise QA1 and QA3.

False positive effect due to changed relationship.

Figure 6.10 QPQAP Analysis Chart and Analysis Comments

If the Estimated Rating is based on customer feedback or the organisation believes the value is genuine then this suggests that there is an anomaly with the Current Rating and therefore in the QPQAP framework and the "What" to "How" translations and their relationships need further consideration to detect the root cause of this mismatch. However, chart analysis indicates that QA1, QA3 and QA5 should be focused upon, and this is not different to the correct chart despite the false positive effect. It appears that when all quality activities are underperforming an incorrect relationship does not mitigate the effect of the poor performance of the quality activities, and the same interventions are still required. Adjustment of the Internal Rating value for QA3 (in order to demonstrate the effect of positive interventions) found that the effects were cascaded through the charts, albeit based on incorrect relationships. It is suggested that the effects of interventions do not create the anticipated results and therefore may be detected by the evaluator who is knowledgeable about the chart content and initiate further investigation into the relationships by the evaluator to determine the cause of the incorrect effect.

Situation 1 Conclusions

Chart testing has shown that when all quality activities are underperforming there is little difference in the chart analysis results for the underperforming activities and it is difficult to identify priorities. The purpose of the QPQAP Framework is to identify improvement priorities and the quality activities requiring attention. It is necessary to distinguish between the quality activities sufficiently in order to identify the key priorities. This justifies the need to ensure the targets are realistic and achievable when they are first determined and should be revised upwards as they are met as part of a continuous improvement theme/programme. It has also identified the need for further research to help with prioritising when all activities are genuinely underperforming.

This testing has also established the need to document reliable Estimated Rating values in the SRP chart. A mismatch between this value and the Current Rating value calculated by the QPQAP Framework is the first indication that the "What" to "How" translations may not be complete and not accurately reflect real relationships. It is important that these two values are the same as it represents a clear understanding of the relationships and where they are not the same then the differences should be investigated.

Finally, it has shown that the detection of incorrect relationships are most likely to be found if the evaluator detects illogical changes in performance as changes are cascaded through the charts, and this emphasises the need for a skilled and knowledgeable individual being allocated the responsibility for chart analysis.

6.3.2.2 Situation 2: All quality activities performing/meeting target.

Scenario 1: Chart correct

The Quality Activity Planning chart was produced so that all quality activities have an Internal Rating value of 5 (Figure 6.11). As this value is cascaded up through the charts it can be seen that all the Current Rating values are 5 too. Therefore it is not possible to analyse the chart to determine quality activity priorities since there are none. In this circumstance it is possible that the company is performing better than it believes, with an Estimated Rating lower than Current Rating (for example Aim 3 and 4, refer to SRP chart) which suggests that since the chart is correct the Estimated Rating value should be adjusted.

Strategy Requirements Planning	Relative Importance	Obj Req 1	Obj Req 2	Obj Req 3	Obj Req 4	Obj Req 5	Actual score	Max score	Performance	Current Rating	Estimated rating
Aim 1	3	9		3			36	36	1.0	5	5
Aim 2	4		9		3		48	48	1.0	5	5
Aim 3	3		3	9	3		45	45	1.0	5	3
Aim 4	5					9	45	45	1.0	5	3
Performance Measures/Targets		95	90	90	99	95					
Absolute scores		27	45	36	21	45					
Relative Ranks		2	4	3	1	4					
Performance rating		1.0	1.0	1.0	1.0	1.0					
Internal rating		5	5	5	5	5					

Performance Objective Planning	Relative Importance	Obj Perf Req 1	Obj Perf Req 2	Obj Perf Req 3	Obj Perf Req 4	Obj Perf Req 5	score	max	performance	current rating	estimated rating
Obj Req 1	2	9					18	18	1.0	5	
Obj Req 2	4		3			9	48	48	1.0	5	
Obj Req 3	3			9	9		54	54	1.0	5	
Obj Req 4	1		9			3	12	12	1.0	5	
Obj Req 5	4			9	3		48	48	1.0	5	
Performance Measures/Targets		90	90	95	99	99					
Absolute score		18	21	63	39	39					
Relative Ranks		1	2	5	3	3					
Performance Rating		1.0	1.0	1.0	1.0	1.0					
Internal rating		5	5	5	5	5					

Performance Measurement Planning	Relative Importance	Dept Perf M1	Dept Perf M2	Dept Perf M3	Dept Perf M4	Dept Perf M5	score	max	performance	current rating	estimated rating
Obj Perf Req 1	1	9					9	9	1.0	5	
Obj Perf Req 2	2		9	9		1	38	38	1.0	5	
Obj Perf Req 3	5	3		9	9		105	105	1.0	5	
Obj Perf Req 4	3	1		3	1		15	15	1.0	5	
Obj Perf Req 5	3		9	3		9	63	63	1.0	5	
Performance Measures/Targets		90	95	99	95	90					
Absolute Score		27	45	81	48	29					
Relative Ranks		1	3	5	4	2					
Performance Rating		1.0	1.0	1.0	1.0	1.0					
Internal rating		5	5	5	5	5					

Quality Activity Planning	Relative Importance	Qual Act 1	Qual Act 2	Qual Act 3	Qual Act 4	Qual Act 5	Actual score	Max score	Performance	Current rating	Estimated rating
Dept Perf M1	1	9					9	9	1.0	5	
Dept Perf M2	3			9	3		36	36	1.0	5	
Dept Perf M3	5		9		9		90	90	1.0	5	
Dept Perf M4	4		9		9		72	72	1.0	5	
Dept Perf M5	2			9		9	36	36	1.0	5	
Performance measures/targets		0	99	90	95	5					
Direction		-1	1	1	1	-1					
Absolute scores		9	81	45	90	18					
Relative Ranks		1	4	3	5	2					
Actual Performance		0	100	91.0	97	4					
Attention Indicator		target	better	better	better	better					
Performance rating		1.0	1.0	1.0	1.0	1.0					
Internal rating		5	5	5	5	5					

Figure 6.11 QPQAP Framework: all activities over performing/on target

Scenario 2: Chart Incorrect

When all quality activities are meeting target and performing then changing any of the relationship strengths does not have any effect as the Current Rating values all stay the same and any anomalies in the relationships are masked. However, if differences between the Estimated Ratings and Current Ratings are revealed then investigations into the reasons for this difference are required. If the Estimated Ratings have been determined by the customer (or the organisation is absolutely certain that it is representative) then the “What” to “How” translations and relationships require investigation as this difference suggests an error exists. There are many opportunities for errors in the charts and a team approach to chart completion may decrease the chances of errors being incorporated or relationships overlooked, alternatively an independent person could check the chart.

Situation 2 Conclusions

Using this situation, that is all quality activities performing to test the QPQAP Framework and Chart Analysis sheets, has supported the requirement to ensure that the performance measures/ targets are reviewed and adjusted regularly so that improvement challenges are available. This is particularly necessary if the targets are intermittent ones being used as part of a CI programme to drive long term performance. Alternatively, if performance is at a stable and desirable level the charts should be reviewed less often, just to check there have been no changes in performance that are having adverse effects. In addition, a regular appraisal of the Estimated Rating should be undertaken, and if it drops below the Current Rating then this should initiate a review of the "What" to "How" translations and relationships as there is now a need to review (and improve) performance. A downwards movement of the Estimated Rating would be due to the competitive environment changing and customers expectations increasing ultimately stimulating the need for improvement. Alternatively, differences in Estimated Rating and Current Rating values suggest that "What" to "How" translations and associated relationships problems which require further investigation. There is a need for reliability in chart completion and an independent cross check of charts or alternative formal mechanism offers opportunity for future research.

6.3.2.3 Situation 3: One quality activity over performing or on target, rest underperforming

Scenario 1: Chart correct

The quality activities internal rating value show that one activity (QA3, selected based on its relationships as noted previously) is over performing or on target and all other activities are underperforming (Figure 6.12) and the associated affects of this on the other charts can be observed. Evaluation of the Analysis Chart (Figure 6.14) reveals that QA2 and QA4 should be prioritised in order to address DPM3 and particularly DPM4 which appears to have the greatest impact on the Current Rating values, since A3 and A4 are the Aims most affected by the underperforming quality activities. The performing quality activity has mediated some of the effects of the underperforming QA5 but it has not overpowered this underperforming activity. Clear priorities for action have emerged from the Analysis Chart.

Strategy Requirements Planning	Relative Importance	Obj Req 1	Obj Req 2	Obj Req 3	Obj Req 4	Obj Req 5	Actual score	Max score	Performance	Current Rating	Estimated rating
Aim 1	3	9		3			27	36	0.7	4	5
Aim 2	4		9		3		37	48	0.7	4	5
Aim 3	3		3	9	3		28	45	0.6	3	3
Aim 4	5					9	25	45	0.5	3	3
Performance Measures/Targets		95	90	90	99	95					
Absolute scores		27	45	36	21	45					
Relative Ranks		2	4	3	1	4					
Performance rating		0.8	0.8	0.6	0.7	0.5					
Internal rating		4	4	3	4	3					

Performance Objective Planning	Relative Importance	Obj Perf Req 1	Obj Perf Req 2	Obj Perf Req 3	Obj Perf Req 4	Obj Perf Req 5	score	max	Performance	Current rating	Estimated rating
Obj Req 1	2	9					14	18	0.8	4	
Obj Req 2	4		3			9	37	48	0.8	4	
Obj Req 3	3			9	9		30	54	0.6	3	
Obj Req 4	1		9			3	9	12	0.7	4	
Obj Req 5	4			9	3		26	48	0.5	3	
Performance Measures/Targets		90	90	95	99	99					
Absolute score		18	21	63	39	39					
Relative Ranks		1	2	5	3	3					
Performance Rating		0.8	0.7	0.5	0.6	0.7					
Internal rating		4	4	3	3	4					

Performance Measurement Planning	Relative Importance	Dept Perf M1	Dept Perf M2	Dept Perf M3	Dept Perf M4	Dept Perf M5	score	max	performance	current rating	estimated rating
Obj Perf Req 1	1	9					7	9	0.8	4	
Obj Perf Req 2	2		9	9		1	27	38	0.7	4	
Obj Perf Req 3	5	3		9	9		57	105	0.5	3	
Obj Perf Req 4	3	1		3	1		8	15	0.6	3	
Obj Perf Req 5	3		9	3		9	50	63	0.8	4	
Performance Measures/Targets		90	95	99	95	90					
Absolute Score		27	45	81	48	29					
Relative Ranks		1	3	5	4	2					
Performance Rating		0.8	0.9	0.5	0.5	0.8					
Internal rating		4	5	3	3	4					

Quality Activity Planning	Relative Importance	Qual Act 1	Qual Act 2	Qual Act 3	Qual Act 4	Qual Act 5	Actual score	Max score	Performance	Current rating	Estimated rating
Dept Perf M1	1	9					7	9	0.8	4	
Dept Perf M2	3			9	3		32	36	0.9	5	
Dept Perf M3	5		9		9		45	90	0.5	3	
Dept Perf M4	4		9		9		36	72	0.5	3	
Dept Perf M5	2			9		9	29	36	0.8	4	
Performance measures/targets		0	99	90	95	5					
Direction		-1	1	1	1	-1					
Absolute scores		18	36	72	48	36					
Relative Ranks		1	4	3	5	2					
Actual Performance		1	92	92.0	91	7					
Attention Indicator		worse	worse	better	worse	worse					
Performance rating		0.8	0.4	1.0	0.6	0.6					
Internal rating		4	2	5	3	3					

Figure 6.12 QPQAP Framework: only one activity over performing or on target

Scenario 2: Chart Incorrect

Changes to the strength of the relationship between DPM2 and QA3 from 9 to 1 resulted in data changing, particularly the Current Rating values through the charts (Figure 6.13). This is evident in the analysis chart (Figure 6.15) which indicates a number of lower Current Rating values which have resulted in an ultimately lower Current Rating for A2. Therefore a false negative has resulted. The evaluation suggests that again QA2 and QA4 should be targeted but this time focus more particularly on DPM3 as it has the greatest effect on the Current Rating values. Changes to other relationship strengths did not cascade though the other charts, which suggests that depending on the Internal Rating values some relationships have less of an effect and not all incorrect relationships will have the same consequences, and therefore the charts are situation specific.

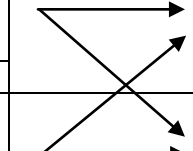
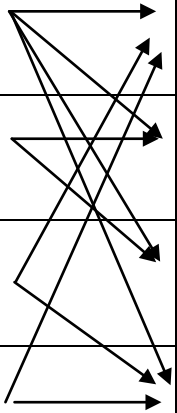
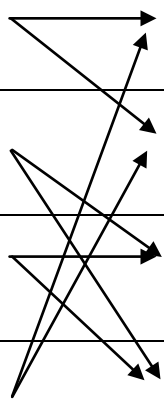
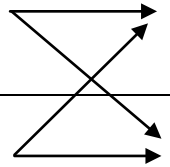
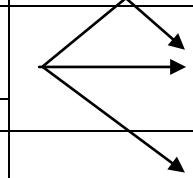
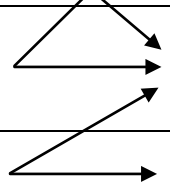
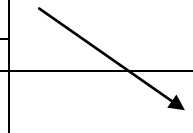
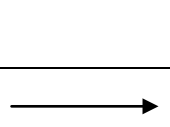
Strategy Requirements Planning	Relative Importance	Obj Req 1	Obj Req 2	Obj Req 3	Obj Req 4	Obj Req 5	Actual score	Max score	Performance	Current Rating	Estimated rating
Aim 1	3	9		3			27	36	0.7	4	5
Aim 2	4		9		3		32	48	0.7	3	5
Aim 3	3		3	9	3		27	45	0.6	3	3
Aim 4	5					9	25	45	0.5	3	3
Performance Measures/Targets		95	90	90	99	95					
Absolute scores		27	45	36	21	45					
Relative Ranks		2	4	3	1	4					
Performance rating		0.8	0.7	0.6	0.6	0.5					
Internal rating		4	3	3	3	3					

Performance Objective Planning	Relative Importance	Obj Perf Req 1	Obj Perf Req 2	Obj Perf Req 3	Obj Perf Req 4	Obj Perf Req 5	score	max	performance	current rating	estimated rating
Obj Req 1	2	9					14	18	0.8	4	
Obj Req 2	4		3			9	33	48	0.7	3	
Obj Req 3	3			9	9		30	54	0.6	3	
Obj Req 4	1		9			3	8	12	0.6	3	
Obj Req 5	4			9	3		26	48	0.5	3	
Performance Measures/Targets		90	90	95	99	99					
Absolute score		18	21	63	39	39					
Relative Ranks		1	2	5	3	3					
Performance Rating		0.8	0.6	0.5	0.6	0.7					
Internal rating		4	3	3	3	4					

Performance Measurement Planning	Relative Importance	Dept Perf M1	Dept Perf M2	Dept Perf M3	Dept Perf M4	Dept Perf M5	score	max	performance	current rating	estimated rating
Obj Perf Req 1	1	9					7	9	0.8	4	
Obj Perf Req 2	2		9	9		1	23	38	0.6	3	
Obj Perf Req 3	5	3		9	9		57	105	0.5	3	
Obj Perf Req 4	3	1		3	1		8	15	0.6	3	
Obj Perf Req 5	3		9	3		9	45	63	0.7	4	
Performance Measures/Targets		90	95	99	95	90					
Absolute Score		27	45	81	48	29					
Relative Ranks		1	3	5	4	2					
Performance Rating		0.8	0.7	0.5	0.5	0.8					
Internal rating		4	4	3	3	4					

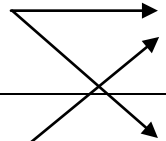
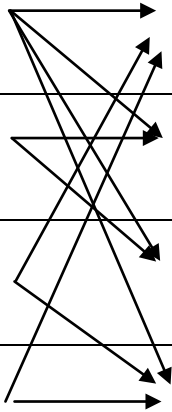
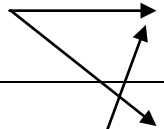
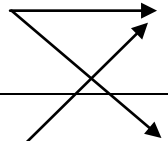
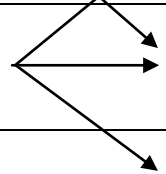
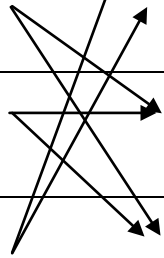
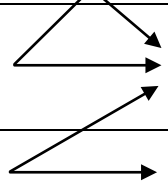
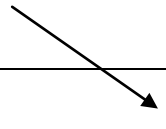
Quality Activity Planning	Relative Importance	Qual Act 1	Qual Act 2	Qual Act 3	Qual Act 4	Qual Act 5	Actual score	Max score	Performance	Current rating	Estimated rating
Dept Perf M1	1	9					7	9	0.8	4	
Dept Perf M2	3			1	3		8	12	0.7	4	
Dept Perf M3	5		9		9		45	90	0.5	3	
Dept Perf M4	4		9		9		36	72	0.5	3	
Dept Perf M5	2			9		9	29	36	0.8	4	
Performance measures/targets		0	99	90	95	5					
Direction		-1	1	1	1	-1					
Absolute scores		9	81	21	90	18					
Relative Ranks		1	4	3	5	2					
Actual Performance		1	92	92.0	91	7					
Attention Indicator		worse	worse	better	worse	worse					
Performance rating		0.8	0.4	1.0	0.6	0.6					
Internal rating		4	2	5	3	3					

Figure 6.13 QPQAP Framework: one activity over performing/on target, relationship incorrect

Quality Activity	Links	Department Performance Measure	Links	Objective Performance Requirement	Links	Objective Requirement	Links	Aims	Comments
QA2 2		DPM3 3		OPR2 4		OR2 4		A2 5 4	
QA4 3		DPM4 3		OPR3 3		OR4 4		A3 3 3	
QA5 3		DPM2 5		OPR4 3		OR3 3		A1 5 4	
		DPM5 4		OPR5 4		OR5 3		A4 3 3	

1. QA2 links to all aims, A3 and A4 have the lowest current rating values.
2. A3 links to QA2 and QA4, and A4 links to QA2 and QA4 also.
3. A4 and A3 have the lowest and aligned Estimated and Current ratings and therefore should be focused on. Though the values for A1 and A2 should be investigated.
4. Prioritise QA2 and QA4 to focus on DPM3 and especially DPM4 as these have the greatest influence through the charts.

Figure 6.14 QPQAP Analysis Chart and Analysis Comments

Quality Activity	Links	Department Performance Measure	Links	Objective Performance Requirement	Links	Objective Requirement	Links	Aims	Comments
QA2 2		DPM3 3		OPR2 3		OR2 3		A2 5 3	
QA4 3		DPM4 3		OPR3 3		OR4 3		A3 3 3	
QA5 3		DPM2 4		OPR4 3		OR3 3		A1 5 4	
		DPM5 4		OPR5 4		OR5 3		A4 3 3	

1. QA2 links to all aims, A2, A3 and A4 have the lowest current rating values.
2. A2, A3 and A4 all link to QA2 and QA4.
3. A4 and A3 have the lowest Estimated and Current ratings and therefore should be focused on. The difference between the Estimated rating and Current rating for A2 should be investigated further and if the Current Rating is reliable, then A2 requires attention also.
4. Prioritise QA2 and QA4 to focus particularly on DPM3.

False negative has been produced. Current ratings are lower as a consequence of the incorrect relationship.

Figure 6.15 QPQAP Analysis Chart and Analysis Comments

Situation 3 Conclusions

When the QPQAP Framework charts and the relationships contained within them are correct, the Analysis Chart has enabled clear priorities to be identified and the effect of the performing quality activity has not been lost. When the QAP chart incorporated an incorrect relationship, this had only a minor effect on the chart analysis results, the same quality activities require improvement only the focus was suggested to be on a different DPM. Therefore although a false negative was indicated it has not had a significant impact at this stage. However, it has indicated a lower performance of A2 and a bigger difference between the Estimated Rating and Current Rating values. It has been suggested in previous sections that differences in these values should be investigated to determine why there is difference between perceived performance and actual. It is envisaged that this investigation would ultimately detect the incorrect relationship. Again, the need for correct relationships and a checking process is emphasised, and the changes indicating the situation specific nature of the Framework support this requirement.

6.3.2.4 Situation 4: One quality activity underperforming

Scenario 1: Chart Correct

The QPQAP Framework, Quality Activity Planning chart (Figure 6.16) includes just one underperforming quality activity (QA2).

Strategy Requirements Planning	Relative Importance	Obj Req 1	Obj Req 2	Obj Req 3	Obj Req 4	Obj Req 5	Actual score	Max score	Performance	Current Rating	Estimated rating
Aim 1	3	9		3			35	36	1.0	5	5
Aim 2	4		9		3		45	48	0.9	5	5
Aim 3	3		3	9	3		39	45	0.9	4	3
Aim 4	5					9	37	45	0.8	4	3
Performance Measures/Targets		95	90	90	99	95					
Absolute scores		27	45	36	21	45					
Relative Ranks		2	4	3	1	4					
Performance rating		1.0	1.0	0.8	0.9	0.8					
Internal rating		5	5	4	5	4					

Performance Objective Planning	Relative Importance	Obj Perf Req 1	Obj Perf Req 2	Obj Perf Req 3	Obj Perf Req 4	Obj Perf Req 5	score	max	performance	current rating	estimated rating
Obj Req 1	2	9					18	18	1.0	5	
Obj Req 2	4		3			9	46	48	1.0	5	
Obj Req 3	3			9	9		45	54	0.8	4	
Obj Req 4	1		9			3	11	12	0.9	5	
Obj Req 5	4			9	3		40	48	0.8	4	
Performance Measures/Targets		90	90	95	99	99					
Absolute score		18	21	63	39	39					
Relative Ranks		1	2	5	3	3					
Performance Rating		1.0	0.9	0.8	0.8	1.0					
Internal rating		5	5	4	4	5					

Performance Measurement Planning	Relative Importance	Dept Perf M1	Dept Perf M2	Dept Perf M3	Dept Perf M4	Dept Perf M5	score	max	performance	current rating	estimated rating
Obj Perf Req 1	1	9					9	9	1.0	5	
Obj Perf Req 2	2		9	9		1	34	38	0.9	5	
Obj Perf Req 3	5	3		9	9		87	105	0.8	4	
Obj Perf Req 4	3	1		3	1		13	15	0.8	4	
Obj Perf Req 5	3		9	3		9	61	63	1.0	5	
Performance Measures/Targets		90	95	99	95	90					
Absolute Score		27	45	81	48	29					
Relative Ranks		1	3	5	4	2					
Performance Rating		1.0	1.0	0.8	0.8	1.0					
Internal rating		5	5	4	4	5					

Quality Activity Planning	Relative Importance	Qual Act 1	Qual Act 2	Qual Act 3	Qual Act 4	Qual Act 5	Actual score	Max score	Performance	Current rating	Estimated rating
Dept Perf M1	1	9					9	9	1.0	5	
Dept Perf M2	3			9	3		36	36	1.0	5	
Dept Perf M3	5		9		9		72	90	0.8	4	
Dept Perf M4	4		9		9		58	72	0.8	4	
Dept Perf M5	2			9		9	36	36	1.0	5	
Performance measures/targets		0	99	90	95	5					
Direction		-1	1	1	1	-1					
Absolute scores		9	81	45	90	18					
Relative Ranks		1	4	3	5	2					
Actual Performance		0	92	92.0	99	4					
Attention Indicator		target	worse	better	better	better					
Performance rating		1.0	0.6	1.0	1.0	1.0					
Internal rating		5	3	5	5	5					

Figure 6.16 QPQAP Framework: one activity underperforming

Quality Activity	Links	Department Performance Measure	Links	Objective Performance Requirement	Links	Objective Requirement	Links	Aims	Comments
QA2 3		DPM3 4		OPR2 5		OR2 5		A2 5 5	
		DPM4 4		OPR3 4		OR4 5		A3 3 4	
				OPR4 4		OR3 4		A1 5 5	
				OPR5 5		OR5 4		A4 3 4	

1. QA2 links to all Aims and particularly affects the performance of A3 and A4.
2. A3 and A4 link back to QA2, with the effects of DPM4 appearing to have the greatest impact.
3. Investigate differences between Estimated and Current Rating values, but given chart correct adjustment to Estimated Rating probably required.
4. QA2 is priority (no others are underperforming) and given effects are mediated it may be necessary to use performance of Aims as a justification for resources to improve QA2.

Figure 6.17 QPQAP Analysis Chart Situation 4: One underperforming quality activity

The Analysis Chart (Figure 6.17) found that QA2 actually links to all the Aims but particularly affects A3 and A4, and that DPM4 has the most significant impact on the Current Rating values. It can be observed that the Estimated Rating for A3 and A4 is lower than the Current Rating and since the chart is correct the Estimated Rating value should be amended. It is obvious from the analysis that QA2 should be prioritised for action (it is the only underperforming quality activity) but as its effects are mediated a little as the Current Rating progress through the chart then it may be possible to use the Aims' (3 and 4) Current Ratings (of 4) to justify focus and resources on the one problematic area.

Scenario 2: Chart Incorrect

The relationship between QA2 and DPM3 was changed (from 9 to 1) and the effects cascaded through the QAQAP framework charts (Figure 6.18).

Strategy Requirements Planning	Relative Importance	Obj Req 1	Obj Req 2	Obj Req 3	Obj Req 4	Obj Req 5	Actual score	Max score	Performance	Current Rating	Estimated rating
Aim 1	3	9		3			35	36	1.0	5	5
Aim 2	4		9		3		47	48	1.0	5	5
Aim 3	3		3	9	3		43	45	0.9	5	3
Aim 4	5					9	41	45	0.9	5	3
Performance Measures/Targets		95	90	90	99	95					
Absolute scores		27	45	36	21	45					
Relative Ranks		2	4	3	1	4					
Performance rating		1.0	1.0	0.9	1.0	0.9					
Internal rating		5	5	5	5	5					

Performance Objective Planning	Relative Importance	Obj Perf Req 1	Obj Perf Req 2	Obj Perf Req 3	Obj Perf Req 4	Obj Perf Req 5	score	max	performance	Current rating	estimated rating
Obj Req 1	2	9					18	18	1.0	5	
Obj Req 2	4		3			9	48	48	1.0	5	
Obj Req 3	3			9	9		49	54	0.9	5	
Obj Req 4	1		9			3	12	12	1.0	5	
Obj Req 5	4			9	3		44	48	0.9	5	
Performance Measures/Targets		90	90	95	99	99					
Absolute score		18	21	63	39	39					
Relative Ranks		1	2	5	3	3					
Performance Rating		1.0	0.9	0.9	0.9	1.0					
Internal rating		5	5	4	5	5					

Performance Measurement Planning	Relative Importance	Dept Perf M1	Dept Perf M2	Dept Perf M3	Dept Perf M4	Dept Perf M5	score	max	performance	current rating	estimated rating
Obj Perf Req 1	1	9					9	9	1.0	5	
Obj Perf Req 2	2		9	9		1	34	38	0.9	5	
Obj Perf Req 3	5	3		9	9		94	105	0.9	4	
Obj Perf Req 4	3	1		3	1		14	15	0.9	5	
Obj Perf Req 5	3		9	3		9	63	63	1.0	5	
Performance Measures/Targets		90	95	99	95	90					
Absolute Score		27	45	81	48	29					
Relative Ranks		1	3	5	4	2					
Performance Rating		1.0	1.0	1.0	0.8	1.0					
Internal rating		5	5	5	4	5					

Quality Activity Planning	Relative Importance	Qual Act 1	Qual Act 2	Qual Act 3	Qual Act 4	Qual Act 5	Actual score	Max score	Performance	Current rating	Estimated rating
Dept Perf M1	1	9					9	9	1.0	5	
Dept Perf M2	3			9	3		36	36	1.0	5	
Dept Perf M3	5		1		9		48	50	1.0	5	
Dept Perf M4	4		9		9		58	72	0.8	4	
Dept Perf M5	2			9		9	36	36	1.0	5	
Performance measures/targets		0	99	90	95	5					
Direction		-1	1	1	1	-1					
Absolute scores		9	81	45	90	18					
Relative Ranks		1	4	3	5	2					
Actual Performance		0	92	92.0	99	4					
Attention Indicator		target	worse	better	better	better					
Performance rating		1.0	0.6	1.0	1.0	1.0					
Internal rating		5	3	5	5	5					

Figure 6.18 QPQAP Framework: One activity under performing, relationship incorrect

The analysis chart (Figure 6.19) found that QA2 had no effect on any of the aims as they all had a current rating value of 5, creating a false positive effect. This should raise doubts in the mind of the person conducting the evaluation concerning the validity of QA2 and its relationships; how can an underperforming quality activity have no impact? In addition, if the Estimated Rating value is lower than the Current Rating then this should also prompt questions and further investigations since the organisation or its customer believes its performance is less than satisfactory too.

Quality Activity	Links	Department Performance Measure	Links	Objective Performance Requirement	Links	Objective Requirement	Links	Aims	Comments
QA2 3		DPM3 5		OPR2 5		OR2 5		A2 5 5	
		DPM4 4		OPR3 4		OR4 5		A3 3 5	
				OPR4 5		OR3 5		A1 5 5	
				OPR5 5		OR5 5		A4 3 5	

1. QA2 links to all Aims but has no effect on their performance due to false positive. The poor performance of QA2 having no impact suggests a relationship error concerning this quality activity.
2. The current rating values suggest that all aims are performing, again at odds with an underperforming quality activity.
3. A3 and A4 have Current Ratings higher than Estimated ratings and therefore require investigation.
4. QA2 as the only underperforming quality activity should be improved.

False positive has been produced.

Figure 6.19 QPQAP Analysis Chart Situation 4: One underperforming quality activity

Since this scenario clearly indicated a problem with the framework and relationships then another incorrect relationship was tested to see if the same happened again. This time the previous changes were put back to their original values and the QA2 DPM4 relationship was changed from 9 to 1, and an analysis chart completed (Figure 6.20). Again a false positive effect was created although A4 does have a slightly improved Current Rating value of 4, rather than the perfect 5 achieved in the previous test. During the analysis stages, it should be noticed by the evaluator that QA2 has no effect on DPM4 which has a current rating of 5 which should suggest that there may be an anomaly with the relationship and further investigation is required along with closer examination of the QPQAP framework. Analysis of this test scenario does suggest that QA2 needs attention.

Situation 4 Conclusions

This situation has demonstrated that the QPQAP Framework and Analysis charts do still identify the quality activity requiring attention and that its underperformance is not outweighed by the performance of the other quality activities.

Another significant finding though has been that this test scenario is able to detect relationship errors in the QAP chart within the QPQAP Framework, through the generation of false positives which upon analysis should seem improbable to the evaluator.

6.3.2.5 Testing: Single Department Conclusions

The testing has established that when the QPQAP Framework charts have been completed correctly, and manipulated with data to reflect the 4 test situations, the analysis charts enable the correct conclusions to be generated in each situation.

The Estimated Rating value in the SRP chart has been demonstrated to be a key figure in the analysis charts as mismatches between this value and the Current Rating can be used to initiate investigations into the “What” to “How” translations and associated relationships. Accurate and reliable ratings for this figure, where possible based on the customers perspective, is a key requirement of the QPQAP Framework.

QAP chart content, particularly concerning quality activities is critical to the success of the QPQAP Framework manipulations and subsequent analysis chart outcomes. By changing the QAP chart relationship matrix to create incorrect relationships, the testing process has shown that only situations 3 and 4 provided genuine tests. Situations 1 and 2 demonstrated the need to ensure that the performance measures/targets set are realistic and achievable.

Quality Activity	Links	Department Performance Measure	Links	Objective Performance Requirement	Links	Objective Requirement	Links	Aims	Comments
QA2 3		DPM3 4		OPR2 5		OR2 5		A2 5 5	
		DPM4 5		OPR3 4		OR4 5		A3 3 5	
				OPR4 4		OR3 4		A1 5 5	
				OPR5 5		OR5 4		A4 3 4	

1. QA2 links to all Aims and particularly affects the performance of A4 only as there is a false positive against A3.
2. Track back to DPM4 identifies a CR value of 5 linking to a QA CR value of 3 which suggests a possible relationship anomaly.
3. Estimated rating values for A3 and A4 are lower than Current Ratings and require investigation.
4. QA2 is only underperforming quality activity for improvement.

False positive has been produced, intermittently through analysis chart due to interactions with other elements of QPQAP chart (not shown).

Figure 6.20 QPQAP Analysis Chart Situation 4: One underperforming quality activity

Easily achieving all targets means that items for further investigation, improvement or intervention are not identified, whereas over ambitious targets means its difficult to distinguish between the underperforming activities and it is difficult to identify and focus on the key performance problems. This has emphasised the need for a cross check process to validate relationships and is an opportunity for future research.

Testing in situation 3 revealed that incorrect relationships generated false negative results. These did not detract from the quality activities requiring attention, but did affect the purpose or need for the attention. In addition the false negatives were not logically detectable or obvious unless a mismatch between Estimated Rating and Current Rating values triggered further investigations. Situation 4 was particularly useful as the false positives could be easily detected in the analysis chart as unlikely current value ratings became apparent and despite an underperforming quality activity the current ratings in the SRP chart became surprisingly high.

Based on these findings it is recommended that the Multi-department testing is conducted for situations 3 and 4 only. In addition, using situation 4 to test for incorrect relationships is recommended for further exploration.

6.3.3 Testing: Multi Department

The multi department testing for the QPQAP Framework has the same purpose as the single department testing; to test the QPQAP Framework and the Analysis Charts. A QPQAP Framework, and the associated SRP, POP, PMP and QAP charts have been compiled with indicative data for a multi-department organisation, consisting of 3 departments. Three departments were selected in order to demonstrate the Framework could cope with a reasonable amount of departments flexibly without being too cumbersome in the analysis phases. Also too many departments may mean that the effects of the quality activities could in theory become so diluted that there would be little impact on the POP and SRP charts despite significant changes in a departments performance in a quality activity. This situation would hinder this testing and analysis, though offers opportunity for future research in term of testing the framework in situations consisting of more than three departments.

In order to simplify the analysis of these more complicated Analysis Charts the Estimated Rating value will also not be considered. Its purpose has already been justified and it should be used for the same purpose in a multi department organisation as it would in a single department company.

6.3.3.1 Situation 3: One quality activity over performing or on target, rest underperforming

Scenario 1 Chart Correct

In order to demonstrate this situation, Quality Activity QA3 has been selected as performing in each department as illustrated in the QFD charts in the QPQAP Framework (Figure 6.21). This quality activity was selected as it has a strong relationship to DPM1 and in turn OPR3, which more importantly has a significant relationship (70% effect on OR) with Department A. Therefore, when the testing is performed then any effects should be more obvious and apparent. The analysis revealed (Figure 6.22) that quality activity QA1 in departments A, B and C should be focused upon. Further review of the QPQAP Framework and Analysis Chart also revealed that the effect of the performing quality activity was not diluted as it cascaded through the charts as Aim 3 is being achieved (Figure 6.21).

Scenario 2 Chart Incorrect

In order to test the effect of an incorrect relationship, DPM1 QA3 relationship strength was changed from 9 to 1. This created a false negative which was cascaded all through the charts as shown on the Analysis Chart (Figure 6.23). It was possible to create a false positive by changing the relationship between DPM5 and QA5 from 9 to 1, though this only cascaded through the charts until the POP chart and the SRP chart remained unchanged (Figure 6.24). A variety of relationships were changed which had effects ranging from inconsequential through to the false positives and negatives previously described. The analysis of these charts still came to the same conclusion as was determined for the correct chart that is Quality Activity QA1 should be focused upon by each of the departments.

Situation 3 Conclusions

The conclusions to this test align with those established in the Single department tests. The analysis charts could be used to determine which quality activity required attention when the relationships were correct. Similarly, when an incorrect relationship was included in the framework the analysis found the same quality activities should be focused upon. It was apparent that in this Situation (one performing quality activity) it is difficult to detect a relationship problem, just by looking at the analysis chart or the QPQAP framework, therefore a checking process is required. As in the single department analysis, it is suggested that the Estimated Rating and Current Rating values for the Aims (in SRP chart) are compared and any differences used to initiate further investigations with the expectation this would detect any obvious issues.

Strategic Requirements Planning	RIR	Obj Req 1	Obj Req 2	Obj Req 3	Obj Req 4	Obj Req 5	score	max	performance	current rating	customer rating
Aim 1	5	9			3		37	60	0.6	3	
Aim 2	2		9			1	14	20	0.7	4	
Aim 3	5			3			14	15	0.9	5	
Aim 4	1		3		9	9	14	21	0.7	3	
Performance Measures/Targets		10	0	99	95	5					
Absolute scores		45	21	15	24	11					
Relative Ranks		5	3	2	4	1					
Performance rating		0.6	0.7	0.9	0.7	0.6					
Internal rating		3	4	5	3	3					

Performance Objectives Planning	RIR	Obj Perf Req 1	Obj Perf Req 2	Obj Perf Req 3	Obj Perf Req 4	Obj Perf Req 5	score	max	performance	current rating	estimated rating
Obj Req 1	5	9					27	45	0.6	3	
Obj Req 2	3		9			3	26	36	0.7	4	
Obj Req 3	2			9	9		32	36	0.9	5	
Obj Req 4	4		1			9	27	40	0.7	3	
Obj Req 5	1	3					2	3	0.6	3	
Performance Measures/Targets		99	90	0	5	3					
Absolute score		48	31	18	18	45					
Relative Ranks		5	3	1	1	4					
Performance Rating		0.6	0.7	1.0	0.8	0.7					
Internal rating		3	4	5	4	3					

Performance Measurement Planning - Dept A	RIR	Dept Perf M 1A	Dept Perf M 2A	Dept Perf M 3A	Dept Perf M 4C	Dept Perf M 5A	score	max	performance	current rating	estimated rating
Obj Perf Req 1	5			9			27	45	0.6	3	
Obj Perf Req 2	3		9			3	26.6	36	0.7	4	
Obj Perf Req 3	1	9					8.6	9	1.0	5	
Obj Perf Req 4	1	3			9		10.1	12	0.8	4	
Obj Perf Req 5	4			3		9	32.4	48	0.7	3	
Performance Measures/Targets		99	95	90	95	99					
Absolute Score		12	27	57	9	45					
Relative Ranks		2	3	5	1	4					
Performance Rating		1.0	0.8	0.6	0.8	0.7					
Internal rating		5	4	3	4	4					

Quality Activity Planning - Dept A	RIR	Qual Act 1A	Qual Act 2A	Qual Act 3A	Qual Act 4A	Qual Act 5A	score	max	performance	current rating	estimated rating
Dept Perf M 1A	2	1		9			19.2	20	1.0	5	
Dept Perf M 2A	3		9			3	27	36	0.8	4	
Dept Perf M 3A	5	9					27	45	0.6	3	
Dept Perf M 4A	1				9		7.2	9	0.8	4	
Dept Perf M 5A	4			3		9	33.6	48	0.7	4	
Performance measure/target		95	5	1.3	99	10					
Direction		1	-1	1	1	-1					
Absolute score		47	27	30	9	45					
Relative Rank		5	2	3	1	4					
Actual Performance		90	10	1.5	92	15					
Attention Indicator		worse	worse	better	worse	worse					
Performance Rating		0.6	0.8	1.0	0.8	0.6					
Internal rating		3	4	5	4	3					

Performance Measurement Planning - Dept B	RIR	Dept Perf M 1B	Dept Perf M 2B	Dept Perf M 3B	Dept Perf M 4B	Dept Perf M 5B	score	max	performance	current rating	estimated rating
Obj Perf Req 1	5			9			27	45	0.6	3	
Obj Perf Req 2	3		9			3	26.6	36	0.7	4	
Obj Perf Req 3	1	9					8.64	9	1.0	5	
Obj Perf Req 4	1	3			9		10.1	12	0.8	4	
Obj Perf Req 5	4			3		9	32.4	48	0.7	3	
Performance Measures/Targets		99	95	90	95	99					
Absolute Score		12	27	57	9	45					
Relative Ranks		2	3	5	1	4					
Performance Rating		1.0	0.8	0.6	0.8	0.7					
Internal rating		5	4	3	4	4					

Quality Activity Planning - Dept B	RIR	Qual Act 1B	Qual Act 2B	Qual Act 3B	Qual Act 4B	Qual Act 5B	score	max	performance	current rating	estimated rating
Dept Perf M 1B	2	1		9			19.2	20	1.0	5	
Dept Perf M 2B	3		9			3	27	36	0.8	4	
Dept Perf M 3B	5	9					27	45	0.6	3	
Dept Perf M 4B	1				9		7.2	9	0.8	4	
Dept Perf M 5B	4			3		9	33.6	48	0.7	4	
Performance measure/target		95	5	1.3	99	10					
Direction		1	-1	1	1	-1					
Absolute score		47	27	30	9	45					
Relative Rank		5	2	3	1	4					
Actual Performance		90	7	1.5	92	12					
Attention Indicator		worse	worse	better	worse	worse					
Performance Rating		0.6	0.8	1.0	0.8	0.6					
Internal rating		3	4	5	4	3					

Performance Measurement Planning - Dept C	RIR	Dept Perf M 1C	Dept Perf M 2C	Dept Perf M 3C	Dept Perf M 4C	Dept Perf M 5C	score	max	performance	current rating	estimated rating
Obj Perf Req 1	5			9			27	45	0.6	3	
Obj Perf Req 2	3		9			3	26.6	36	0.7	4	
Obj Perf Req 3	1	9					8.64	9	1.0	5	
Obj Perf Req 4	1	3			9		10.1	12	0.8	4	
Obj Perf Req 5	4			3		9	32.4	48	0.7	3	
Performance Measures/Targets		99	95	90	95	99					
Absolute Score		12	27	57	9	45					
Relative Ranks		2	3	5	1	4					
Performance Rating		1.0	0.8	0.6	0.8	0.7					
Internal rating		5	4	3	4	4					

Quality Activity Planning - Dept C	RIR	Qual Act 1C	Qual Act 2C	Qual Act 3C	Qual Act 4C	Qual Act 5C	score	max	performance	current rating	estimated rating
Dept Perf M 1C	2	1		9			19.2	20	1.0	5	
Dept Perf M 2C	3		9			3	27	36	0.8	4	
Dept Perf M 3C	5	9					27	45	0.6	3	
Dept Perf M 4C	1				9		7.2	9	0.8	4	
Dept Perf M 5C	4			3		9	33.6	48	0.7	4	
Performance measure/target		95	5	1.3	99	10					
Direction		1	-1	1	1	-1					
Absolute score		47	27	30	9	45					
Relative Rank		5	2	3	1	4					
Actual Performance		90	10	1.5	92	15					
Attention Indicator		worse	worse	better	worse	worse					
Performance Rating		0.6	0.8	1.0	0.8	0.6					
Internal rating		3	4	5	4	3					

Figure 6.21 QPQAP Framework Multi Dept: one activity performing

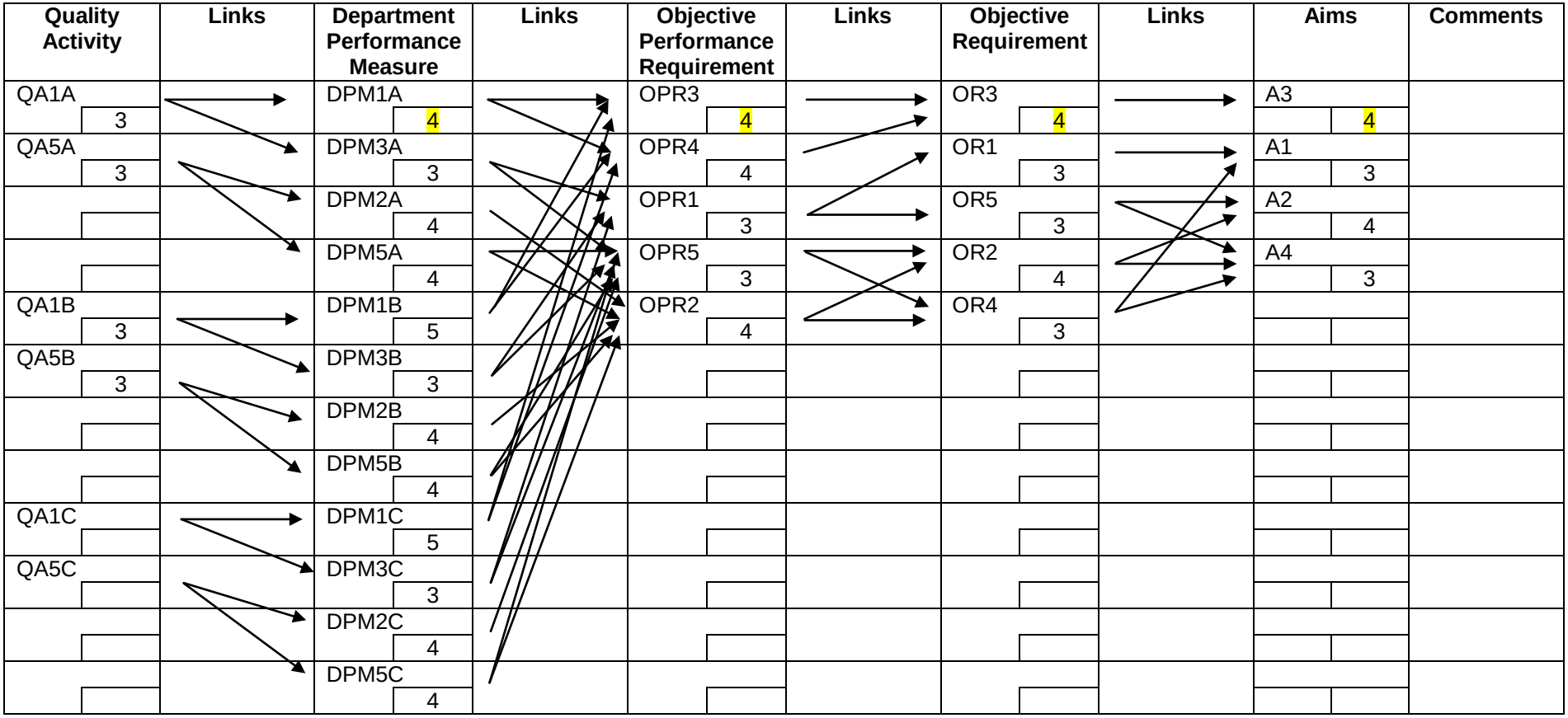
Quality Activity	Links	Department Performance Measure	Links	Objective Performance Requirement	Links	Objective Requirement	Links	Aims	Comments
QA1A 3		DPM1A 5		OPR3 5		OR3 5		A3 5	
QA5A 3		DPM3A 3		OPR4 4		OR1 3		A1 3	
		DPM2A 4		OPR1 3		OR5 3		A2 4	
		DPM5A 4		OPR5 3		OR2 4		A4 3	
QA1B 3		DPM1B 5		OPR2 4		OR4 3			
QA5B 3		DPM3B 3							
		DPM2B 4							
		DPM5B 4							
QA1C		DPM1C 5							
QA5C		DPM3C 3							
		DPM2C 4							
		DPM5C 4							

Following poorest performance links QA1A/1B/1C to DPM3A/3B/3C to OPR1 and OPR5 and finally A1 and A4.

1. This is replicated by the backward track from A1 and A4. Effects of QA5A/B/C are diluted.
2. N/A (see commentary)
3. Prioritise QA1A/B/C.

Figure 6.22 QPQAP Analysis Chart

Quality Activity	Links	Department Performance Measure	Links	Objective Performance Requirement	Links	Objective Requirement	Links	Aims	Comments
QA1A 3		DPM1A 4		OPR3 4		OR3 4		A3 4	
QA5A 3		DPM3A 3		OPR4 4		OR1 3		A1 3	
		DPM2A 4		OPR1 3		OR5 3		A2 4	
		DPM5A 4		OPR5 3		OR2 4		A4 3	
QA1B 3		DPM1B 5		OPR2 4		OR4 3			
QA5B 3		DPM3B 3							
		DPM2B 4							
		DPM5B 4							
QA1C		DPM1C 5							
QA5C		DPM3C 3							
		DPM2C 4							
		DPM5C 4							



1. Following poorest performance links QA1A/1B/1C to DPM3A/3B/3C to OPR1 and OPR5 and finally A1 and A4.
2. This is replicated by the backward track from A1 and A4. Effects of QA5A/B/C are diluted.
3. N/A (see commentary)
4. Prioritise QA1A/B/C.

False negative caused by changing the strength of the relationship between DPM1 and QA3 from 9 to 1.

Figure 6.23 QPQAP Analysis Chart

Quality Activity	Links	Department Performance Measure	Links	Objective Performance Requirement	Links	Objective Requirement	Links	Aims	Comments
QA1A 3		DPM1A 5		OPR3 5		OR3 5		A3 5	
QA5A 3		DPM3A 3		OPR4 4		OR1 3		A1 3	
		DPM2A 4		OPR1 3		OR5 3		A2 4	
		DPM5A 5		OPR5 4		OR2 4		A4 3	
QA1B 3		DPM1B 5		OPR2 4		OR4 4			
QA5B 3		DPM3B 3							
		DPM2B 4							
		DPM5B 4							
QA1C		DPM1C 5							
QA5C		DPM3C 3							
		DPM2C 4							
		DPM5C 4							

1. Following poorest performance links QA1A/1B/1C to DPM3A/3B/3C to OPR1 and OPR5 and finally A1 and A4.
2. This is replicated by the backward track from A1 and A4. Effects of QA5A/B/C are diluted.
3. N/A (see commentary)
4. Prioritise QA1A/B/C.

False positive caused by changing the strength of the relationship between DPM5 and QA5 from 9 to 1.

Figure 6.24 QPQAP Analysis Chart

6.3.3.2 Situation 4: One quality activity underperforming

Scenario 1 Chart Correct

The QPQAP framework was created with one quality activity underperforming. Quality Activity QA1 was selected as it has one strong and two weak relationships (Figure 6.25) linking to a number of items as it cascades through the charts and therefore it is envisaged that the test will show that its' effects are not masked by the performing quality activities. A completed analysis chart (Figure 6.26) shows the linkages and quality activity QA1 requires attention in each department, therefore the priority is clear.

Scenario 2 Chart incorrect

A number of relationships were falsified to determine their effect on the QPQAP framework and subsequent analysis. It was found that by changing the relationships DPM1 and QA3 from 9 to 1 in Department A (and also Department B and C separately) a false negative was generated that cascaded through the charts, in the case of Department A, whereas only the QAP and PMP charts were affected when the relationships were changed in Department B and C. This was also found when the relationship between DPM1 and QA1 was changed from 1 to 9. Given that these tests did not show the same results as the Single Department tests (which produced a false positive), the QPQAP framework was adjusted so that QA2 became the underperforming quality activity rather than QA1. It was observed that again the effect of this underperforming quality activity cascaded through the charts and when the relationship DPM1A QA1A was changed from 9 to 1 a false positive was produced that cascaded up through the charts. In addition this false positive was replicated when the charts for department B and C were adjusted to show this false relationship. As in the Single Department testing this false positive is "obvious" when the charts are analysed and therefore a review of the relationships should detect the problem.

Situation 4 Conclusions

Situation 4 has shown that the QPQAP Framework and Analysis charts ensure that an underperforming quality activity does impact on the results even when the other activities are all performing.

The investigation into incorrect relationships established that false negatives and false positives could be produced. In particular it is possible to create a test condition (improbable false positives) that can detect errors, obvious to the evaluator, in the QAP relationships in the QPQAP framework. This requires further investigation.

Strategic Requirements Planning	RIR	Obj Req 1	Obj Req 2	Obj Req 3	Obj Req 4	Obj Req 5	score	max	performance	current rating	customer rating
Aim 1	5	9			3		31	60	0.5	3	
Aim 2	2		9			1	18	20	0.9	5	
Aim 3	5			3			14	15	1.0	5	
Aim 4	1		3		9	9	14	21	0.7	3	
Performance Measures/Targets		10	0	99	95	5					
Absolute scores		45	21	15	24	11					
Relative Ranks		5	3	2	4	1					
Performance rating		0.4	1.0	1.0	0.9	0.4					
Internal rating		2	5	5	4	2					

Performance Objectives Planning	RIR	Obj Perf Req 1	Obj Perf Req 2	Obj Perf Req 3	Obj Perf Req 4	Obj Perf Req 5	score	max	performance	current rating	estimated rating
Obj Req 1	5	9					18	45	0.4	2	
Obj Req 2	3		9			3	35	36	1.0	5	
Obj Req 3	2			9	9		35	36	1.0	5	
Obj Req 4	4		1			9	35	40	0.9	4	
Obj Req 5	1	3					1	3	0.4	2	
Performance Measures/Targets		99	90	0	5	3					
Absolute score		48	31	18	18	45					
Relative Ranks		5	3	1	1	4					
Performance Rating		0.4	1.0	0.9	1.0	0.9					
Internal rating		2	5	5	5	4					

Performance Measurement Planning - Dept A	RIR	Dept Perf M 1A	Dept Perf M 2A	Dept Perf M 3A	Dept Perf M 4C	Dept Perf M 5A	score	max	performance	current rating	estimated rating
Obj Perf Req 1	5			9			18	45	0.4	2	
Obj Perf Req 2	3		9			3	36	36	1.0	5	
Obj Perf Req 3	1	9					8.46	9	0.9	5	
Obj Perf Req 4	1	3			9		11.8	12	1.0	5	
Obj Perf Req 5	4			3		9	40.8	48	0.9	4	
Performance Measures/Targets		99	95	90	95	99					
Absolute Score		12	27	57	9	45					
Relative Ranks		2	3	5	1	4					
Performance Rating		0.9	1.0	0.4	1.0	1.0					
Internal rating		5	5	2	5	5					

Quality Activity Planning - Dept A	RIR	Qual Act 1A	Qual Act 2A	Qual Act 3A	Qual Act 4A	Qual Act 5A	score	max	performance	current rating	estimated rating
Dept Perf M 1A	2	1		9			18.8	20	0.9	5	
Dept Perf M 2A	3		9			3	36	36	1.0	5	
Dept Perf M 3A	5	9					18	45	0.4	2	
Dept Perf M 4A	1				9		9	9	1.0	5	
Dept Perf M 5A	4			3		9	48	48	1.0	5	
Performance measure/target		95	5	1.3	99	10					
Direction		1	-1	1	1	-1					
Absolute score		47	27	30	9	45					
Relative Rank		5	2	3	1	4					
Actual Performance		90	3	1.5	99	5					
Attention Indicator		worse	better	better	target	better					
Performance Rating		0.4	1.0	1.0	1.0	1.0					
Internal rating		2	5	5	5	5					

Performance Measurement Planning - Dept B	RIR	Dept Perf M 1B	Dept Perf M 2B	Dept Perf M 3B	Dept Perf M 4B	Dept Perf M 5B	score	max	performance	current rating	estimated rating
Obj Perf Req 1	5			9			18	45	0.4	2	
Obj Perf Req 2	3		9			3	36	36	1.0	5	
Obj Perf Req 3	1	9					8.46	9	0.9	5	
Obj Perf Req 4	1	3			9		11.8	12	1.0	5	
Obj Perf Req 5	4			3		9	40.8	48	0.9	4	
Performance Measures/Targets		99	95	90	95	99					
Absolute Score		12	27	57	9	45					
Relative Ranks		2	3	5	1	4					
Performance Rating		0.9	1.0	0.4	1.0	1.0					
Internal rating		5	5	2	5	5					

Quality Activity Planning - Dept B	RIR	Qual Act 1B	Qual Act 2B	Qual Act 3B	Qual Act 4B	Qual Act 5B	score	max	performance	current rating	estimated rating
Dept Perf M 1B	2	1		9			18.8	20	0.9	5	
Dept Perf M 2B	3		9			3	36	36	1.0	5	
Dept Perf M 3B	5	9					18	45	0.4	2	
Dept Perf M 4B	1				9		9	9	1.0	5	
Dept Perf M 5B	4			3		9	48	48	1.0	5	
Performance measure/target		95	5	1.3	99	10					
Direction		1	-1	1	1	-1					
Absolute score		47	27	30	9	45					
Relative Rank		5	2	3	1	4					
Actual Performance		90	3	1.5	99	5					
Attention Indicator		worse	better	better	target	better					
Performance Rating		0.4	1.0	1.0	1.0	1.0					
Internal rating		2	5	5	5	5					

Performance Measurement Planning - Dept C	RIR	Dept Perf M 1C	Dept Perf M 2C	Dept Perf M 3C	Dept Perf M 4C	Dept Perf M 5C	score	max	performance	current rating	estimated rating
Obj Perf Req 1	5			9			18	45	0.4	2	
Obj Perf Req 2	3		9			3	36	36	1.0	5	
Obj Perf Req 3	1	9					8.46	9	0.9	5	
Obj Perf Req 4	1	3			9		11.8	12	1.0	5	
Obj Perf Req 5	4			3		9	40.8	48	0.9	4	
Performance Measures/Targets		99	95	90	95	99					
Absolute Score		12	27	57	9	45					
Relative Ranks		2	3	5	1	4					
Performance Rating		0.9	1.0	0.4	1.0	1.0					
Internal rating		5	5	2	5	5					

Quality Activity Planning - Dept C	RIR	Qual Act 1C	Qual Act 2C	Qual Act 3C	Qual Act 4C	Qual Act 5C	score	max	performance	current rating	estimated rating
Dept Perf M 1C	2	1		9			18.8	20	0.9	5	
Dept Perf M 2C	3		9			3	36	36	1.0	5	
Dept Perf M 3C	5	9					18	45	0.4	2	
Dept Perf M 4C	1				9		9	9	1.0	5	
Dept Perf M 5C	4			3		9	48	48	1.0	5	
Performance measure/target		95	5	1.3	99	10					
Direction		1	-1	1	1	-1					
Absolute score		47	27	30	9	45					
Relative Rank		5	2	3	1	4					
Actual Performance		90	4	1.5	99	5					
Attention Indicator		worse	better	better	target	better					
Performance Rating		0.4	1.0	1.0	1.0	1.0					
Internal rating		2	5	5	5	5					

Figure 6.25 QPQAP Framework Multi Dept: One activity underperforming

Quality Activity	Links	Department Performance Measure	Links	Objective Performance Requirement	Links	Objective Requirement	Links	Aims	Comments
QA1A 2		DPM1A 5		OPR3 5		OR3 5		A3 5	
		DPM3A 2		OPR4 5		OR1 2		A1 3	
QA1B		DPM1B 5		OPR1 2		OR5 2		A2 5	
		DPM3B 2		OPR5 4		OR2 5		A4 3	
QA1C		DPM1C 5				OR4 4			
		DPM3C 2							

Analysis

1. QA1A/B/C link to underperforming aims A1 and A4 and DPM3A/B/C appears to be the critical performance measure.
2. A1 and A4 link to QA1A/B/C
3. N/A
4. Priority clear. Focus on QA1A/B/C to target DPM3A/B/C.

Figure 6.26 QPQAP Analysis Chart

6.3.3.3 Testing: Multi Department Conclusions

Based on the findings for the Single Departments, QPQAP Frameworks for Situations 3 and 4 were created for a multi department organisation and then evaluated using the analysis charts. This revealed that in both situations the analysis charts identified quality activities to be focused upon for improvement. In addition, changes represented the proportional influences of the departments within the framework with those departments of lesser influence changes affecting the QPQAP charts to a lesser extent as changes did not cascade all the way through.

In Situation 3, falsifying the relationships created false positives and negatives which cascaded through the charts to varying extents. The analysis of these revealed that the quality activities were identified for further attention were those determined when the chart was correct. However the incorrect relationships could not easily be identified. As in the Single department scenario, a mismatch between the Estimated Rating and Current Rating values for the Aims could be used to initiate an investigation into the relationships, but this relies on a mismatch being produced, and this cannot be guaranteed. Therefore a cross check system is required.

Analysis of Situation 4 revealed that it was possible to find/determine a quality activity which could be used when generating the incorrect relationships to create a false positive result (as occurred in the Single Department testing). This false positive was obvious upon chart analysis and can therefore initiate the investigation into the relationships. This knowledge should be considered as the basis for a method for testing the relationships and explored further.

6.4 Testing Review

The QPQAP Framework testing described herein has demonstrated that the QPQAP Framework is able to link quality activities to an organisation's strategic quality aims. In addition changes in the performance of the quality activities are accurately cascaded through the charts.

The Analysis Charts presented in this chapter have been successfully used to identify which quality activities should be focused upon in order to improve an organisation's performance and can therefore be considered as the preferred method for Chart Analysis.

The QPQAP Framework, through the QAP chart, has had the relationships manipulated to generate “incorrect relationships” and test the effect of these on the Framework and the analysis. Using the Analysis Charts has established that the incorrect relationships have not affected which quality activities should be focused upon. However it was found that the incorrect relationships are hard to detect, and investigation into relationships would mainly be triggered as a consequence of a difference between the Estimated and Current Rating values. Therefore this testing has demonstrated the need to have an independent cross check process and robust evaluation process and ensure that the Estimated Rating is a genuine value. An incorrect relationship may be detected once interventions have been made and achieved a positive outcome which subsequently does not have the desired effect on performance according to the Framework, but the evaluator may have other indicators which suggest the intervention has been a success. For example, the quality activity may be at target performance and the Estimated Rating suggests that the customer is satisfied, but the Current Rating has a lower value and therefore the Framework is not reflecting the true situation.

The incorrect testing was based on falsifying only one relationship on the QAP chart. It is possible that more than one relationship could be incorrect and therefore the effects of multiple incorrect relationships offer the opportunity for further testing and possible future research. Also, as explained earlier the most likely problem relationships would be with the QAP chart, however, it is not inconceivable that an incorrect relationship could exist in one of the other charts, and therefore this would need further investigation.

In creating Situation 4 (one quality activity underperforming) the testing found that obvious false positives could be generated. It is suggested that this is explored further as it has potential to form the basis of a trouble shooting system which detects incorrect relationships.

The chart analysis and testing process has also demonstrated that the QAP chart and in particular knowledge about quality activities and their performance is a critical element of the QPQAP Framework. Therefore there is an essential need to ensure reliable, detailed information about the specific quality activities a company is engaged in which can be used to inform the judgements made in the QAP chart.

The nature of QFD means that there is not a definitive method in existence which can determine whether the QFD charts and the data within them are correct. It relies on the individual which completes them. Similarly, this testing process has shown that a variety of possibilities exist and therefore there may not be a single correct answer rather the testing process has demonstrated that it is a method for developing and refining the QFD charts to provide an “optimum” solution.

However, if the charts are completed accurately and checked as they are generated, with particular care being paid to the Estimated Rating values, the performance measure targets and the relationships (and associated strengths), then it would appear from the testing that the QPQAP Framework and Analysis Charts are robust enough to use.

6.5 Chapter Summary

Chapter 6 has detailed the QPQAP Framework analysis process for both single and multi-department organisations. The chart analysis should start with Pre-Analysis checks, to check the "What" to "How" translations and their relationships. Once there is confidence in the charts within the QPQAP Framework it is then possible to complete an Analysis Chart and use it to identify the quality activities to focus upon in order to improve performance. The Analysis Chart also reveals which Aims are affected the most by the underperforming quality activities, which may influence the activities to focus on. The testing process established that the QPQAP Framework links quality activities to aims and changes in performance of the quality activities can be cascaded through the charts depending on their relationships and performance value. Testing demonstrated that incorrect relationships did not affect which quality activities should be focused upon although it did highlight detecting incorrect relationships was difficult and it suggested that performance interventions may not accurately be reflected as a consequence. The testing process also emphasised the importance of ensuring that the primary data used to complete the charts is correct, particularly the "What" to "How" translations, the relationships (and their strength), and the Estimated Rating values. Further work to establish a cross check system for validating relationships is required. Also, the need for further research to explore the use of false positives to detect relationship problems and investigate a trouble shooting methodology has been identified. Finally, the QAP chart is the primary chart within the QPQAP Framework and reliable data about the quality activities is essential for the generation of correct analysis chart outcomes.

7.1 Introduction

Employee Involvement (EI) was identified in the Literature Review (Chapter 2) as a key component of a quality programme and fundamental to continuous improvement and the application of quality activities (tools and techniques) particularly at an operational level in a manufacturing organisation. It was noted that the existing research focused on the soft elements of EI within TQM and the actual deployment and application of quality activities by manufacturing personnel has not been examined.

The case study research (Chapter 4) identified that quality activities, both embedded day-to-day and project based, were the foundations of an organisations' quality programme and used to drive improvement in performance measures. This concept underpins the QPQAP Framework (described in Chapter 5 and 6) and the fulfilment of quality activities and their link to performance is the mechanism for enabling an organisations quality strategy to be achieved.

Therefore this research has examined the activities performed by manufacturing employees in order to establish their involvement in the application of operational quality activities (tools and techniques) and ultimately their contribution to the quality programme. This led to the development of the Activity Classification System which can be used to evaluate the tasks performed by an individual, particularly the quality orientated ones. This information can then be used to inform and evaluate the interventions required and the performance decisions necessary to manipulate and use the Quality Activity Planning (QAP) chart within the QPQAP Framework.

This chapter summarises the creation, development and refinement of the Activity Classification System which was completed in accordance with the research methodology documented in Chapter 3. The research methodology identified the need to conduct exploratory research in this area. The research was divided into two separate studies with different purposes. Study One was based on some fundamental questions concerning the research methods and theoretical underpinnings in this research area which ultimately led to the development of a tentative hypothesis and questions and a preliminary version of a set of definitions and framework. Study Two continued the exploratory theme and developed and refined the early findings and definitions and framework, leading to further research questions.

7.2 Activity Classification System Creation: Study One

7.2.1 Overview

In order to investigate Employee Involvement (EI) in quality programmes at an operational level within manufacturing the research examined the activities of manufacturing personnel. The literature review established that manufacturing personnel's jobs had previously been viewed as consisting of Direct and Indirect Activities, although detail about these activities and in particular their relationship with quality activities is not apparent. The first element of this exploratory research, contained in Study One, is designed in order to test the research methods, particularly the data collection techniques, and secondly to conduct preliminary analysis which could be used to start the theory building process in this area.

Four questions were posed in Chapter 3, Research Methodology (section 3.2.2)

1. What is a suitable method for collecting data concerning the use of quality activities in an individual's day-to-day role?
2. What are the quality activities that an individual engages in? Can these be separated from their other tasks, that is, can they be individually identified and analysed?
3. Can a set of definitions and framework be created which will facilitate consistent analysis of the activities?
4. Can the results of such an analysis be used to guide employee involvement and manage quality activities to the benefit of the organisation?

This research, Study One, will focus on questions 1, 2 and 3 in order to start to build theory and lead investigations around question 4.

This phase of the research was conducted at a manufacturing organisation with an externally formally recognised successful approach to quality management. The company had recently won the Midlands EFQM Award and in addition held a variety of quality approvals. Detailed information and a justification for the research methodology for this phase of the research can be found in Chapter 3, section 3.6. Details of the data collection and analysis are contained in the Case Study Report, Appendix A5.

7.2.2 Data Collection Summary

Participant Observation was the only means of collecting data during Study One and in addition access to the organisation was restricted although when on site the information/data was freely available. Therefore, two days were spent observing manufacturing personnel at this case study company. One day was spent with a Cell Member (production worker) and

the other day with a Team Leader (production worker with supervisory and organisational responsibilities).

7.2.3 Data Analysis Summary

Data analysis based on a content-led analytic approach has used the categories Direct and Indirect as a rough guide at the start of the analysis process. The analysis involved assessing every task and classifying it for both the Cell Member and Team Leader. This was done iteratively, so that over a period of time, thoughts could be gathered, and definitions (for Direct and Indirect activities) and method (for classification) could emerge from the research (as in the case of grounded research), by filtering out discrepancies in the iterations (Appendix A5 details this process). These led to the creation of workable definitions (Figure 7.1) and the creation of a framework to facilitate a consistent task analysis classification method (Figure 7.2). The framework (Figure 7.2) provides a systematic method which can be followed to enable employees' activities to be classified according to the criteria and together with the definitions is called the Activity Classification System (ACS).

Direct Activity: Are those tasks considered inherent and comprise of the main job function (often detailed in the job description). Typically direct activities are value adding or directly contribute to the value adding tasks, for example, set-up, production, and inspection. Therefore direct activities are intrinsic to the job function, offer opportunity for improvement in the way a task is done and directly contribute to quality and hence improved performance.

Indirect Activity: Are those tasks which do not directly contribute to value adding activities and are typically extrinsic to the normal job function. Indirect activities may include training, continuous improvement activities, helping/supervising peers.
Normally indirect activities contribute to quality performance by enabling improvement in the direct activities, and tend not to directly affect quality in the same way as direct activities.

Personal: This includes all activities that are essential but do not contribute to the job function or company business in anyway. It includes refreshment breaks, toilet breaks etc, outside of allocated times (i.e. lunch time).

Figure 7.1 Definitions: Direct and Indirect Time (Cooke and Goodyer 2000)

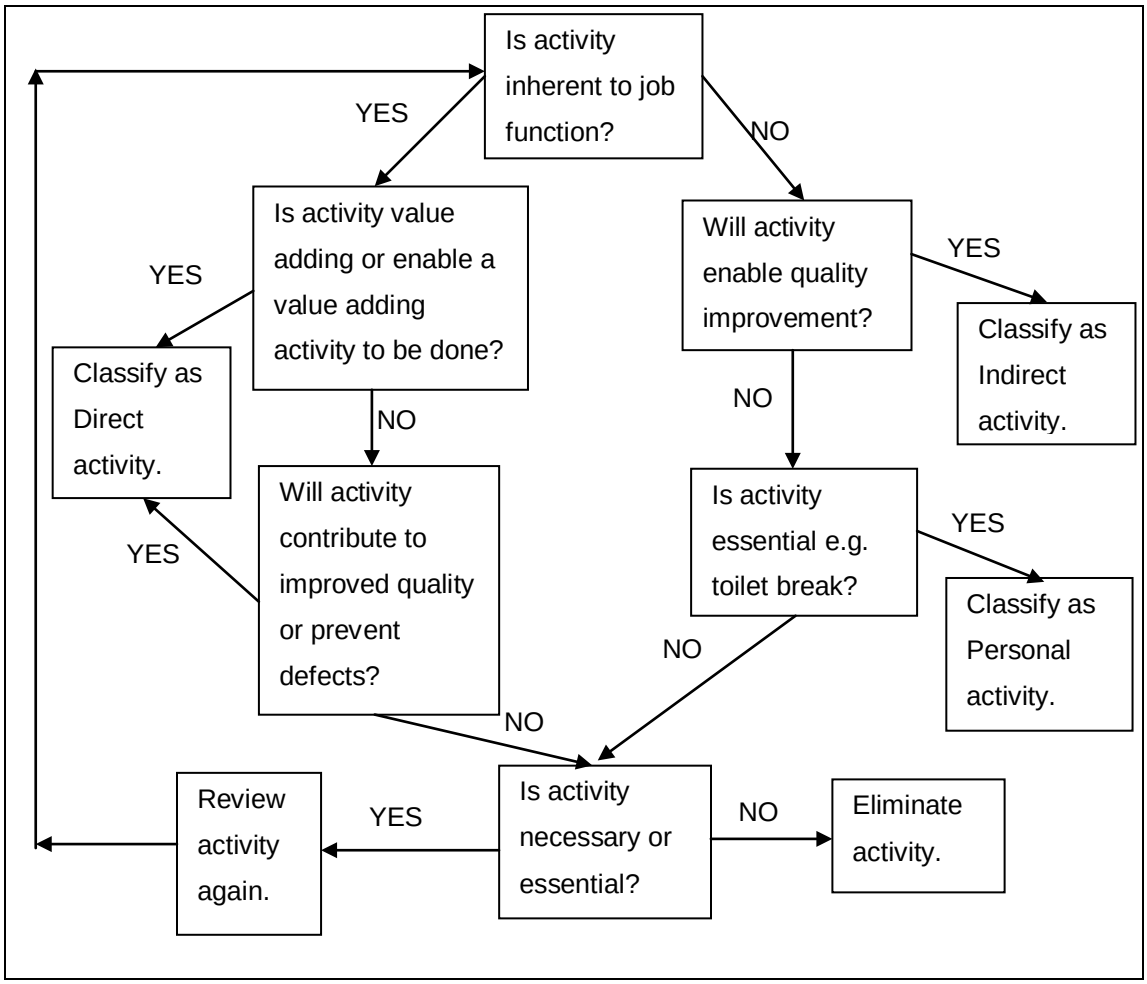


Figure 7.2 Activity Classification Framework (Cooke and Goodyer 2000)

7.2.4 Review of Study One and Conclusions

Study One was conducted in order to explore the data collection method, subjects and tentative questions listed previously (in 7.2.1).

In terms of data collection, this data is rich and contextual and has enabled detailed analysis at a level not previously documented in this research field. However, the short amount of time spent on Participant Observation, two days, has provided only limited data – a snap shot, and different activities may be observed over a longer time frame. The short time duration of the tasks, along with the numerous interruptions that the Team Leader experienced and the double emphasis on time and activity made data recording very difficult at times and despite meticulousness of the observer there could be a few anomalies. A lack of knowledge of the manufacturing facility and process because the researcher had "gone in cold" could have contributed to any possible anomalies. The use of an independent recorder has provided genuine and reliable data. In addition the smallest recordable time frame needs to be

established. This research worked to the nearest minute, but when activities may last seconds then is this acceptable? These issues could be investigated and overcome with an in depth study.

The depth of the description in the contextual data collected has enabled quality activities to be identified and analysed. The cellular small batch environment provided a wide variety of tasks for observation and in particular has emphasised the variety in the quality activities (both direct and indirect) undertaken by an individual.

The definitions for Direct and Indirect that have evolved are practical and can be easily applied to activity description data obtained in this study. The Personal category could prove contentious but these activities clearly need to be separate from direct and indirect activities in order to not interfere with any analysis or future actions. The approach to and management of these activities should be considered prior to starting observations at other organisations.

By observing different roles it increased the variety of activities available to observe and emphasised these differences and that the quality activities crossed job roles.

7.2.5 Further Research Questions and Recommendations

This study has shown it is possible through participant observation to collect data and collate it in a suitable format to analyse an individuals activities. The study also enabled the creation of potential definitions and a possible framework to facilitate the categorisation of activities. As the first stage in an exploratory study a tentative hypothesis and supporting questions have been created from this preliminary work and earlier questions in order to guide further research:

Tentative Hypothesis:

Can the definitions of Direct Activity and Indirect Activity along with the Activity Classification Framework be used to consistently analyse a variety of roles within a manufacturing environment and identify the quality activities an individual engages in.

This hypothesis supports the earlier question (specified in 7.2.1), "Can the results of such an analysis be used to guide employee involvement and manage quality activities to the benefit of the organisation?" If the quality activities that an individual engages in can be identified then they can be managed in order to focus on improving quality performance.

Questions

1. *Can the definitions and activity classification framework be used to consistently categorise an individuals activities?*
2. *Can the definitions be applied within a variety of roles in a manufacturing environment?*
3. *Do the categories adequately identify quality activities?*
4. *Are definitions more specific to quality activities required in order to extract this information more readily from the data?*
5. *How can the quality activities identified be analysed to facilitate improvement opportunities?*

In order to investigate questions 1 and 2 further, based on the earlier findings, an in depth study preferably in a cellular manufacturing environment is recommended. An in depth study will serve two main purposes. Firstly it will enable a deeper understanding of the organisation, the type of work and activities that are regularly performed, which will enhance the reliability and accuracy of the data collected and in turn facilitate the analysis and classification of the activities. This will inform whether the definitions work or need refinement and in turn lead to developments of the framework. Secondly an in depth study will facilitate access to a range of individuals with different job roles in the same manufacturing environment. The contentious Personal category should appear less so in the eyes of the observed as there will be greater trust in the observer and understanding of the purpose of the research. Therefore another case study will enable the definitions to be tested (possibly refined) and also review whether the Activity Classification framework enables easy and consistent analysis of the data collected. It will also provide additional information about the validity of the research methodology.

Questions 3, 4 and 5 are closely linked and form the purpose/intention of this research. Both Direct and Indirect activities seem to offer the opportunity for improving quality performance. For example, a direct task could include checking documentation, this could prevent the wrong drawing issue being worked to and hence prevent scrap. This activity could be viewed as good practice and directly contributes to quality. It may or may not be done as a matter of routine. Alternatively, non-robust direct activities are likely to have an adverse affect on quality performance. An indirect activity, such as teamwork, may prevent errors occurring, as a more knowledgeable person guides someone of lesser experience in how to do a job. Again this may or may not be a matter of routine at an organisation and could offer opportunity for improving quality performance. Other indirect activities such as a Kaizen Day can also be considered in this manner. An in depth study will provide greater opportunity for identifying a variety of direct and indirect quality activities. A method which enables analysis of the specific quality activity data should be considered particularly with reference to existing literature in the field. It may be possible to identify a potential list of quality activities which

may contribute to improved performance. In addition, a model to explain the contribution of both direct and indirect activities to improved quality performance may be beneficial particularly to help an organisation plan and manage employee involvement through its' direct and indirect quality activities.

7.3 Activity Classification System Development: Study Two

7.3.1 Overview

This case study (at a new organisation) is a continuation of the exploratory research previously described but has been guided by the tentative hypothesis and refined questions which have emerged from the findings of the first investigation.

The rationale for the organisation selection and methodological approach is detailed in Chapter 3 Research Methodology. The company used for this in depth study, is a medium sized aerospace component/assembly manufacturer which has over 900 employees and holds a number of externally recognised quality approvals (including BS EN ISO 9000 AS EN 9100, Tick IT, and various aircraft constructor approvals). The manufacturing area is arranged into product-based cells, called modules. Permission was granted to focus the research in one of these product-based cells and a confidentiality agreement was required.

7.3.2 Data Collection Summary

This study was conducted over a three month period, where the researcher visited on average at least one day per week over this period. The primary data (contained in the case study database) was obtained through participant observation as in the first study and the data recording and collection method replicated that followed previously. In addition the researcher became embedded in the organisation and was able to attend and observe departmental (module) meetings, meet other employees and have access to documentation which could be read at leisure and appropriate notes made. This original data is also contained within the case study database.

7.3.3 Data Analysis Summary

The main purpose of the data analysis is the theoretical refinement of the definitions and framework which emerged from the preliminary study. The data analysis will also focus on the specific quality activities which were performed with a view to answering the tentative questions concerning the specific identification of quality activities, whether there is a link to existing literature from the activities and linking both direct and indirect activities to improving quality performance.

Therefore the analysis consisted of four main stages following an iterative analytic approach to evaluating the data. Each stage built on the results from the previous so that it is possible to build accurate and appropriate definitions and a framework. Firstly, this process started with the basic categories of Direct and Indirect Activities based on the definitions which emerged during the preliminary study. Then this was followed by a detailed examination of the observed activities to tease out the quality activities. Next these activities were subjected to an analysis based on existing quality activity categories in the literature. These three stages consisted of within case analysis (that is, analysing the individuals' activities) and then a cross case analysis in which the overall findings were compared for the analysis stage. Finally, building on the findings so far, suggestions and modifications have been identified in order to refine the research results and lead to the development of a model and set of definitions which will enable the identification of quality activities. During the activity analysis process comments were noted, at the end of the tasks descriptions, by the researcher for later consideration.

As noted by Cooke and Goodyer (2000), the personal time category is potentially contentious. This was found to be the case at the case study company. Therefore the category, whilst used in data collection was referred to simply as PT. It was removed from the data analysis since by its nature it does not include quality activities but could distort the proportion of time spent on direct or indirect activities had it not been recorded.

7.4 Activity Classification System Refinement

In order to create a clear distinction between Direct and Indirect quality activities they have been renamed as Embedded (day-to-day) Quality Activities and Quality Improvement Projects respectively in order to more accurately reflect the nature of the activities. A comparison of the different types of activities has been generated (Table 7.1) in order to emphasise the differences that exist and inform the creation of revised definitions.

Quality Improvement Projects	Embedded (day-to-day) Quality Activities
Formerly Indirect	Formerly Direct
Management led, project manager.	Locally led, shop floor / operations managed.
Long time scale.	Short time scale.
May normally require resources from outside departments.	Local resource only.
Large project (with respect to cost &/or time).	Minimal cost / time requirements.
Easy to identify.	Difficult to identify.
Comprises a limited number of activities.	Comprises many types of quality activities.
Done to focus on one specific performance target/goal.	Impacts on several performance measures / targets.
Only proactive.	Can be reactive as a consequence of poor quality.
Tasks in addition to normal job function.	Tasks intrinsic to job.
Can be quality specific or part of organisation wide improvement programme to improve a significant problem.	Used to check/maintain/assess product or process against requirements to maintain current performance. (Failure to do tasks could result in poor quality).
Often technique/tool implementation orientated (e.g. SPC, 5S).	Involves use of known existing tools/techniques to improve or address simple quality problems
On successful completion may lead to day-to-day activities e.g. from SPC implementation to SPC chart completion.	

Table 7.1 Comparison of Embedded and Improvement Project Quality Activities

A revised set of definitions have been created which are based on the findings from the analysis stages, particularly Stage 4, and the comparison of the different types of quality activities (Table 7.1).

Embedded (day-to-day) Quality Activities (formerly Direct Activities)

Manufacturing personnel should engage in a variety of quality activities during their day-to-day responsibilities. There are three main types:

1. Compliance and Control. These quality activities are those that can control the process and ensure compliance to operational requirements. This activity can include for example, inspection, testing, TPM, 5S (e.g. tidying work area), OEE, and SPC (e.g. completing control charts). These activities maintain existing quality performance levels.
    a. Failure to do these activities may have a negative impact on quality performance. These activities may offer opportunity for improvement in the way they are done or by implementing new compliance and control techniques. Also, an organisation may wish to implement these activities in

order to control / assure quality e.g. SPC, TPM, in which case the implementation of such a technique would be a quality improvement project (indirect activity).

   b. The extent to which an organisation and individuals engages in these types of activities is likely to indicate quality performance levels. Failure to do these types of activities would have a negative impact on performance but doing them does not necessarily improve performance. However, these activities offer long term opportunities for improvement (either local projects or major projects) but require process redesign in order to improve the efficiency and effectiveness of how they are performed.

2. Corrective Action. These activities arise as a result of defects occurring and are necessary to investigate and correct the initial defect. Such activities include rework, completing concessions/scrap dockets, rejecting/returning goods to suppliers and liaising with defect originators. In addition, more direct quality activities could result from poor communication or a lack of team working.
   a. The activities are reactive and essentially a waste of resources and therefore should be completely eliminated. Often Corrective Action activities have a direct alignment with poor quality performance measures e.g. scrap costs. High levels of this type of activity should indicate poor quality performance.
   b. Data collected as a result of Corrective Action may indicate where improvement activities (local or project) are required to identify the type of compliance/control activity that is needed. If an organisation is busy reacting to problems this may mean that there is insufficient time and resources to invest in the compliance/control and improvement activities
3. Prevention and Improvement. These activities can contribute to improved quality and are small local-led improvements to process/product achieved through minor changes in order to prevent problems occurring. These may be being performed in order to address local / cell / department performance measures or to overcome a recent poor trend. These activities will require proactive activities and resources (time & money) which are within departmental control. These may lead to a compliance and control activity being introduced and therefore have a direct immediate impact on quality performance or alternatively a larger issue requiring a significant improvement project may be identified.
   a. It is suggested that an organisation that spends time preventing problems and introducing improvements should have higher levels of quality performance.

<u>Quality Improvement Projects (formerly Indirect Activities)</u>

These activities are extrinsic to the normal job function and do not directly contribute to the day-to-day value adding activities. These activities are often managed or led from outside the

department and may be part of a larger project. They contribute to improved quality performance in the long term may be as a result of their recommendations or project outcomes. They do not have a direct immediate impact on local quality performance measures.

These revised definitions have been incorporated into the amended Activity Classification Framework (Figure 7.3). Examination of the framework shows that the categories of direct and indirect have been kept so that they can be used to classify non-quality related activities to ensure completeness of the framework. For example, direct (non-quality) activities would typically involve those activities involved in production or mainstream job description items that are unrelated to quality. Indirect (non quality) activities would again be work related tasks outside of the normal job description, for example, going to a Union meeting or training course.

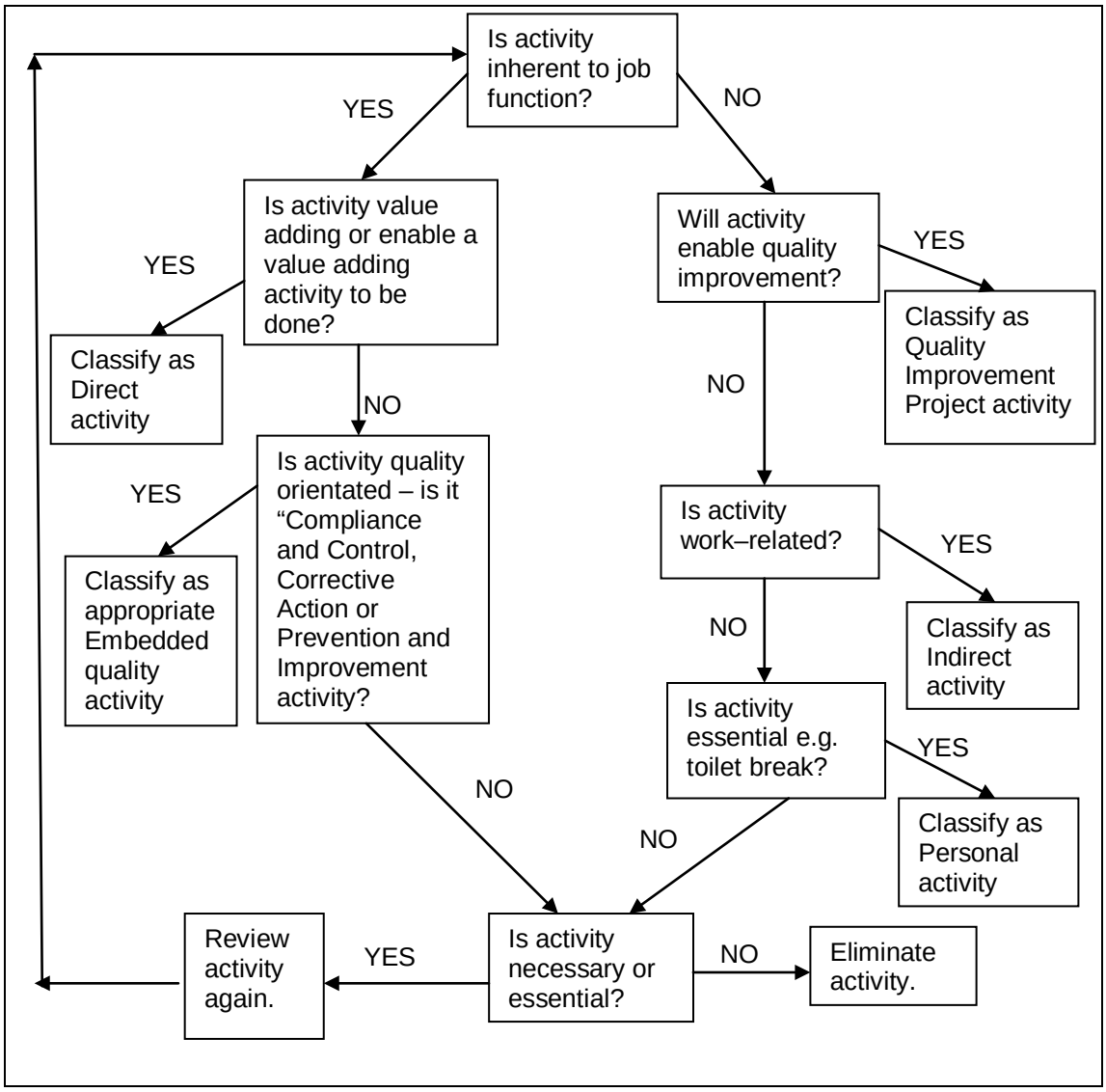


Figure 7.3 Revised Activity Classification System Framework

7.5 Activity Classification System Review

In order to review the Activity Classification System (the definitions and framework) it is necessary to evaluate it from two perspectives. Firstly, from a research perspective, has the Tentative Hypothesis and Questions (in 7.2.5) been addressed and what are the key issues that emerged from the research process. Secondly the Activity Classification System should be examined from a theoretical perspective in order to establish how it integrates and aligns with existing theoretical academic literature.

7.5.1 Definitions and Framework Review

The two studies in this exploratory research have led to the creation and development of definitions and a framework which can be used to analyse the quality practices of individuals. However the definitions and framework need evaluating with regard to the tentative hypothesis and questions, so that further hypotheses can be created in line with the intended research outcomes of exploratory investigations.

Firstly the questions will be considered, followed by the tentative hypothesis.

Questions

1. *Can the definitions and activity classification framework be used to consistently categorise an individuals activities?*

Study One started with very vague definitions as to how to analyse an individuals time, that is direct time and indirect time. The analysis process led to specific definitions for these categories which incorporated quality activities and a framework based on a flowchart could be followed to allocate activities to the categories. Study Two used these developed definitions to analyse a greater variety of activities. These studies found that the definitions and a framework, as a conceptual principle, could be used to perform categorisation. However, by the end of the analysis process it was necessary to refine the definitions and amend the framework.

2. *Can the definitions be applied within a variety of roles in a manufacturing environment?*

Study Two collected data from seven different people, six of whom had substantially different roles. It was apparent that quality activities crossed role boundaries and the evolving definitions and framework could be easily applied across all the observed roles. None of the roles provided greater obstacles than others in terms of categorisation. Similarly during the

analysis process the reasons for the iterations in the definitions were not specific to an individual but were often across roles even though the precise scenario and activity differed.

3. *Do the categories adequately identify quality activities?*

The original definitions for Direct and Indirect activities which emerged from Study One when used for further categorisation of quality activities in Study Two were found to be too simplistic and did not pick up some of the complexities surrounding the nature of quality activities which the in depth study had revealed. Therefore, by modifying the definitions, examining literature and reviewing and reflecting on the quality activities again, it was determined that detailed definitions that reflect the operational nature of quality activities in a manufacturing environment were required.

4. *Are definitions more specific to quality activities required in order to extract this information more readily from the data?*

The new definitions are based on Embedded (day-to-day) quality activities and Improvement Project activities in order to clearly distinguish between two categories and therefore enable data categorisation and analysis. The Embedded category has been subdivided in order to reflect the nature of organisational manufacturing quality activities and in doing so facilitate categorisation. The sub categories are: Compliance and Control; Corrective Action; and Prevention and Improvement.

5. *How can the quality activities identified be analysed to facilitate improvement opportunities?*

By definition, Improvement Project activities are improvement orientated and therefore analysing the activities themselves in unlikely to prove beneficial. However, from a managerial perspective if improvement projects are being undertaken by an individual where subsequent task analysis has revealed no/little time spent on the improvement project then this sort of data may enable better management of the project to facilitate the projects resolution. No improvement projects may indicate that poor performance could be investigated and improved by such a project. This could be linked to the QPQAP framework.

Embedded quality activities offer a variety of opportunities for improvement depending on the category. Compliance and Control activities can be examined from several perspectives. Are sufficient activities being undertaken, that is, should the organisation be doing more both in terms of the type of activity and secondly in terms of the time spent on them. There is also the opportunity to examine this type of quality activity and if they are too time consuming could they be redesigned to make them more efficient and effective. Compliance and Control activities could be evaluated using appropriate performance measures – are they achieving them, should more demanding targets be set, or maybe the activities, despite their

performance are not having any organisational impact. These points can be addressed by linking the ACS with the QPQAP framework.

The Corrective Action category has the potential to offer the most immediate and direct improvement opportunities. The data can be analysed to determine which are the most time consuming and most frequent problems and therefore need addressing through improvement activities. In addition, an overview of the proportion of time on these activities in relation to the others and non-quality activities may give an indication to the overall performance – too much time would suggest poor quality performance. This poor performance could be indicated on the QPQAP framework.

The Prevention and Improvement category will provide an indication of whether any minor quality improvement activities are being performed and the type of activities being done. Reoccurring preventions offer the opportunity to investigate and redesign a process with a view to them becoming a Compliance and Control activity. No Prevention and Improvement activities may suggest that the Corrective Actions are not leading into any improvements and therefore a management intervention could possibly initiate some improvement opportunities. The Prevention and Improvement activities can also be evaluated for their effectiveness by linking them to performance measures to determine whether the organisation is achieving maximum benefits. This would be through linking to the QPQAP framework.

Tentative Hypothesis:

The definitions of Direct Activity and Indirect Activity along with the Activity Classification Framework can be used to consistently analyse a variety of roles within a manufacturing environment and identify the quality activities an individual engages in.

With regard to this specific hypothesis it has been necessary to rename and redefine the quality activities an individual engages in and therefore amend the activity classification framework appropriately. Two main categories of quality activity have been created:

1. Embedded (day-to-day) quality activities which comprises three sub categories: compliance and control; corrective action; prevention and improvement. These are intrinsic to the main job function.
2. Quality Improvement Projects. These quality activities are extrinsic to an individuals' main role.

The improved Activity Classification system and definitions have led to a modified hypothesis:

Revised Hypothesis:

The definitions for Embedded Quality Activity and Quality Improvement Projects along with the Activity Classification Framework can be used to consistently analyse a variety of roles within a manufacturing environment and identify the quality activities an individual engages in.

This hypothesis will need testing in order to validate the definitions and framework. However, the ACS enables data about an individuals activities to be classified (Figure 7.4)

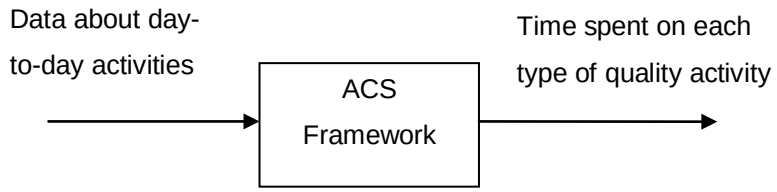


Figure 7.4 Overview of ACS

If the findings from Study One and Study Two are compared to an earlier more generic research question (specified in 7.2.1), "Can the results of such an analysis be used to guide employee involvement and manage quality activities to the benefit of the organisation?" it can be argued, by reviewing the answers to the previously stated questions that this question can be answered positively. Organisations can determine and evaluate the activities being performed and consider whether the types of activities need changing. In addition, if the data from the activity classification system is combined with the QPQAP framework it would suggest that there are a variety of ways that an individuals quality activities can be managed to achieve improved quality performance.

7.5.1.1 Research Methodology Review

A case study based methodology and participant observation has resulted in rich contextual data concerning the activities that an individual performs in on a day-to-day basis. The in depth study proved to be particularly useful as the researcher could gain a deeper insight into the purpose of the actions and how these related to different roles across the manufacturing area. The large variety of activities performed supports the original proposition to investigate in a cell based organisation. Although this made data analysis more complicated the definitions that have emerged reflect typical activities. However, the data collection was time consuming, and given that in most cases less than half the time of an individual was spent on quality activities then a method suitable for more easily and quickly capturing the data is required. In addition, depending on the manufacturing environment it may be necessary to

consider the smallest recordable time frame for which data should be captured. Study Two worked in minutes, and the preliminary investigations and observations indicated that the tasks did not change rapidly. This is in contrast to Study One where at times the researcher felt that a smaller time frame would have been ideal, though it was not possible when recording by hand to use a smaller time frame. Therefore, in further studies of this nature, it is recommended that a method suitable for reliably recording the quality activity data is developed, and if possible the format designed to enable categorisation which will facilitate subsequent analysis. Finally if the ultimate aim is to relate the quality activities to quality performance then data obtained over a longer time frame is required and the research must also consider whether a time lag exists between any improvement interventions and changes in performance levels.

7.5.2 Theoretical Review

The purpose of this theoretical review is to compare the ACS to existing literature in order to find support for the proposals, as suggested by Miles and Hubermann (1994). It should be noted that the two different main types of quality activities emerged from the research presented in Chapter 4, and therefore have been justified therein (section 4.8).

Research (Ang 2002) identified a need for investigations into the day-to-day realities of employee involvement so that organisations can evaluate the context and structure concerning how an EI programme is operationalised so that appropriateness and effectiveness can be assessed with regard to organisational success.

The ACS provides a means for organisations to examine the detail concerning the nature of the quality activities pursued by individuals on a day-to-day basis. It will provide information to enable the context of the type of activities to be evaluated, both at an overview level (by way of categorisation) but also the data captured will illustrate precise activities. This level of information can inform management about the structure of their EI programme.

Organisations will be able to use this information to guide evaluations about the maturity of their quality programme and the effectiveness of their TQM journey if used in conjunction with the levels proposed by Dale and Lascelles (1997) or Bessant and Francis (1999). For example, Bessant and Francis (1999) define Level 2 organisations focus on problem finding and solving (which aligns with the Corrective Action category) and in order to move to Level 3 organisations need to provide time and space for activities and embed key behaviours to do existing activities better, which supports the Prevention and Improvement activity and the overall theme of embedded quality activities. Similar synergies can be found within Dale and Lascelles (1997) work.

Similar support for the ACS can be found within the five classes of activity proposed by Bateman (2005) in order to achieve sustainability of process improvements. Bateman believes that sustainable improvement requires contribution and buy-in from the shop floor which can be evaluated with the ACS. In addition she advocated that new work practices must be maintained, issues closed out and CI focused on which align with the embedded day-to-day practices and the corrective action and prevention and improvement categories.

Likewise, Lewis *et al* (2006) developed core sub criteria of CI, which included a process improvement category which contained items related to; employees inspecting their own work (a compliance and control activity), fixing problems they find and correcting quality problems (a corrective action activity), and problem solving network (a prevention and improvement type activity).

It is noticeable that Zhang (2000) and Mann and Kehoe (1994) who articulate quality management methods and quality activities respectively in their TQM frameworks, include some items which are either compliance and control or prevention and improvement, but do not include corrective action type reactive quality activities. In addition, other models also focus on the ideal state for TQM. Reactive quality activities are realistic and reflect some modern manufacturing organisations current practice (for example Case Study Company B, Chapter 4 refers). Though not ideal, their identification through the ACS can inform organisations that there is a need to change the balance away from these activities and start to adopt other types of activities.

The categories of embedded activity share commonality with the Prevention, Appraisal, Failure (PAF) quality costing model categories (BS 6143, Millar 1999) since the prevention costs reflect the prevention and improvement activity, the appraisal costs align with the compliance and control activity and the Failure (internal) costs could emerge as a result of corrective action activities.

Finally, research investigating whether work measurement practices and TQM practices could be used by organisations without problems found that measurement did not negatively affect CI or quality (Sadikoglu 2005). Therefore the data collection and analysis required as part of the ACS should not cause TQM focused organisations a problem.

It is clear from the suggestions above that there is alignment between the ACS and existing research and models which as well as supporting the ACS offers opportunities for further research.

7.6 Chapter Summary

This Chapter has described the exploratory research involved in the creation and development of the Activity Classification System. The Activity Classification System consists of a set of definitions and a framework which can be used to identify and categorise quality activities.

Participant Observation and recording every activity performed followed by a content led analytic approach has enabled categories to emerge from the research which are based on rich contextual data and reflect the nature of quality activities that individuals in manufacturing organisations may engage in.

Two main categories have been identified:

1. Embedded (day-to-day) quality activities. This category consists of three types:
    a. Compliance and Control
    b. Corrective Action
    c. Prevention and Improvement
2. Improvement Projects quality activities.

Identification and classification of quality activities into these revised categories should enable an organisation to reflect on the type of quality activities, the associated proportion of time spent on them and the related performance measures and ultimately guide management actions.

The chapter has discussed how these different categories can be used to improve quality performance and in addition has linked these categories to the previously developed QPQAP Framework (Chapters 5 and 6).

8.1 Introduction

The purpose of this chapter is to review and critically evaluate, in the context of existing published research, the original models presented in this thesis. Firstly they will be reviewed separately, and then the application of the models as a combined approach to total quality management and the management of an organisations quality programme will be discussed. Finally, as is the nature of exploratory research, further research questions will be identified in order to develop this study further.

8.2 QPQAP Framework

A theoretical discussion of the QPQAP Framework was presented earlier (Chapter 4, section 4.8) and this evaluated the conceptual framework and found support for the different elements within it, from a theoretical perspective. This discussion will focus more specifically on a practitioner and application focus of the model, supported where appropriate by existing research.

The QPQAP Framework enables an organisation to link strategy through performance measurement to specific quality activities. This meets the need identified by Leonard and McAdam (2004) for TQM models to include strategic, tactical and operational levels, and these have been annotated on the QPQAP Framework (Figure 8.1).

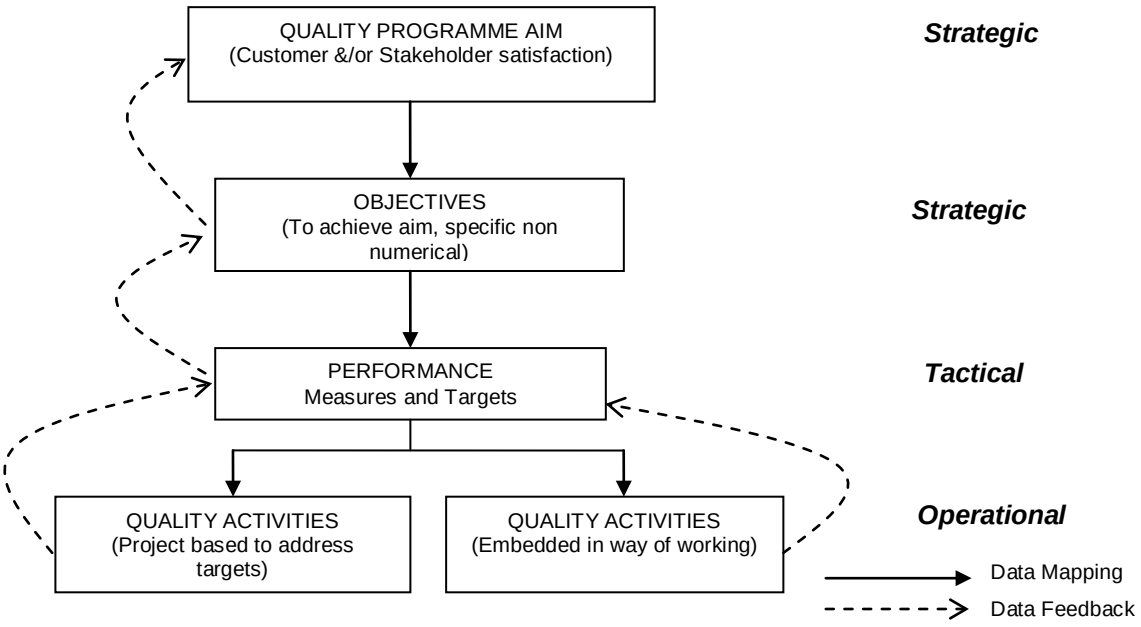


Figure 8.1 QPQAP Framework including the Leonard and McAdam (2004) levels (shown in bold)

Research (Mehra *et al.* 2001) in predicting the future of TQM identified that TQM would "shift towards a philosophy of quality based strategic management systems". The literature review identified research (Dale and Lascelles 1997, Beecroft 1999, Tena *et al.* 2001, Dale *et al.* 2001, Dayton 2003) which acknowledged the need for quality to be managed strategically. There is also increasing support for the alignment of quality strategy with improvement processes (Carpinetti *et al.* 2000, Dale and Lascelles 1997, Bessant and Francis 1999, Ingle 2000). Idris and Zairi (2006) insist that corporate goals and quality strategies are aligned to ensure business growth. Half of the QPQAP Framework is designed to focus on articulating and deploying strategic quality requirements.

Therefore, organisations which have a strong strategic focus can use the QPQAP framework, so that their strategy can be used as a starting point for driving the implementation and/or (increasing) usage of quality activities. Organisations without strong strategy and direction can use the framework as a starting point for the strategic quality management process and focus for their quality programme.

In the Leonard and McAdam (2004) model, Key Points of TQM Application, a tactical level is identified yet unlike the strategic and operational elements, techniques or activities are not assigned to it, despite the authors' TQM organisational profiles model clearly depicting a role for the tactical level of TQM. This research has found the tactical level need in TQM can be addressed through performance measurement and management. Therefore the QPQAP framework has identified a tactical level and constructed a content which organisations can use to manage the link between strategy and operations. Thawesaengskulthai and Tannock (2008) suggest there is a missing link between operations strategy and the rational decision required to select CI approaches. Performance objectives and measures are this link in the QPQAP Framework. The need for a link between strategic TQM and the tactical level is supported by research (Chang and Sinclair 2003) particularly through the use of performance measures (Najmi and Kehoe 2001, Sinclair and Zairi 2001, McAdam and Bailie 2002). Research (Sousa *et al.* 2005) found that despite quality being a strategic objective in SME's that quality performance measures were not considered important and suggested that strategy and performance measures are not always aligned. The QPQAP Framework can overcome this problem by creating alignment.

Organisations can use performance measures to manage the quality programme in accordance with the quality strategy. Using the definitions for performance measurement, reporting and performance management (Radnor and Barnes 2007) it would appear that the QPQAP Framework could be defined as a performance measurement, reporting and performance management system, therefore further work investigating this possibility is suggested.

The investigations to establish the existence of quality practices at a tactical level found that despite three data sources the extent of existence of quality practices could not be confirmed (despite data triangulation through the use of pre-validated questionnaire, interviews and documentation), and in particular organisations did not refer to the term quality practice. It was noticeable that practitioners did not use quality practices to manage quality, although research advocates the existence of such as essential elements of TQM. A number of issues arose through using the three data sources, particularly because the interview and documentation confirmed that Company B did not have a quality programme yet the questionnaire responses did not establish this fact. Similarly, concerning the existence of quality practices at the organisations, using the three data sources meant that conclusions could not be established for some practices due to a lack of consensus between the evidence. It is recommended that these issues concerning quality practices are further investigated.

The operational level of the QPQAP framework has been identified as quality activities. It was established that quality activities are the fundamental element of a quality programme, yet the organisations did not evaluate activities before selecting them for implementation or use and neither did they monitor their effectiveness. Lagrosen and Lagrosen (2003) were alarmed to note that some companies had not noted positive effects from their quality activities. Use of this QPQAP Framework, by linking quality activities to performance measures, will enable organisations to modify their actions so that positive (or negative) effects can be monitored and managed. The QPQAP Framework has separated quality activities into two categories of improvements which are incremental or step changes (supported by Pun and Gill 2002, Tonnessenn 2005, Palmberg and Garvare 2008). It was noted that relatively few tools and techniques were used by the case study organisations, which is supported by research (Sousa *et al.* 2005) which found only ten from forty possible tools had any significant usage, with only seven tools being used more than a moderate amount. Similarly Fotopoulos and Psomas (2009) found quality tools and techniques were not used to a large extent and companies did not integrate them into everyday practices. Also, research (Palmberg and Garvare 2006) noted the need for day-to day embedded quality activities. It is believed that the QPQAP Framework will enable organisations to identify quality activities which can be embedded into day-to-day work practices, so that they become the “way of working” at the organisation. Over time, it is anticipated that a greater range of tools and techniques will be used as they become embedded, and the less effective ones replaced by other quality activities to improve performance.

Organisations which are strong in the deployment of quality activities can use the QPQAP framework to align their activities with the company strategy, and in turn justify their actions and use of resources through the performance monitoring process. Organisations which use few tools can use the QPQAP Framework to facilitate and justify the selection and

deployment of more tools and techniques. The QPQAP Framework will enable organisations to directly monitor the effects of quality activities and therefore manage the activities deployed.

The use of performance measures within the QPQAP framework enables a formal review process to be conducted, which facilitates a feedback process and therefore a cyclic continuous improvement loop. This allows quality programmes to be re-energised as benefits from one quality activity may fade and alternative activities can be adopted. This addresses the dynamic requirement (Leonard and McAdam 2004) of TQM models. Idris and Zairi (2006) propose a model for sustainable TQM which "links the goals, drives, and strategies and performance of TQM initiatives". The QPQAP framework does this and therefore could be argued to be a model for sustainable TQM, particularly as it has the dynamic feedback loop (whereas the Idris and Zairi (2006) model does not include any feedback or continuous loop).

Organisations will benefit from the QPQAP Framework as it facilitates CI and re-energising of quality activities and therefore enables an organisations' quality programme to be dynamic and sustainable.

Sousa *et al.* (2005) identified a need for a Framework for SME's in which a performance measurement system could be created that aligned with strategy and tools, in order to achieve predetermined goals. The QPQAP framework fulfils this need and it is suggested that SME's could adopt it, subject to further research. Similarly it is believed that any organisation that does not have a formal structured approach to managing their quality programme (such as Company B, case study organisation) could adopt the QPQAP Framework and use it to drive quality and guide the implementation of tools and techniques.

The development of the QPQAP Framework has met the need for theory development identified by research (Handfield and Melnyk 1994, Dale *et al.* 2001, Leonard and McAdam 2004). The QPQAP Framework enables organisations to plan and co-ordinate their quality activities in order to optimise (or maximise) performance in line with the strategic quality requirements of the company.

8.2.1 QPQAP Development

Quality Function Deployment (QFD) was selected as the most suitable approach to adapt for the deployment of the QPQAP Framework. However, it has already been suggested that either the Balanced Scorecard or Hoshin Kanri may be suitable and offer opportunity for further research. In fact, research by Witcher and Chau (2007) proposed a model which blends together both the Balanced Scorecard and Hoshin Kanri as a model for strategic management, therefore targeted at senior management to enable them to manage the

dynamic capabilities of the organisation. This model appears more complex than the QFD based four phase approach described herein, as it comprises more elements, though is ideologically similar in as much as it is advocated as a method of managing the dynamic capabilities of an organisation.

Prior to developing QFD, “working” definitions and examples have been provided for the QPQAP Framework elements in order to facilitate chart completion. The literature review noted the general lack of agreement in definitions and therefore this research has established a set which can be tested at organisations at the same time as the framework.

The deployment process uses a simplified QFD chart (Figure 5.4), which does not have a “roof” (correlation matrix) to include the effect of interactions between the “Hows”, that is they are considered to be independent and mutually exclusive. This has initially been addressed by stating that the performance measures selected for each of the quality activities should only reflect the performance of the activity and not be subject to interactions from other activities. However, this may be oversimplifying the relationships since specific between quality activity relationships (and relationships between other “Hows”) as well the effects of possible interactions between performance measures have not been considered. There is significant scope for further research looking more specifically at relationships between “Hows”, particularly quality activities and also between activities and performance measures.

The method for adopting the QFD process for multi-department organisations has assumed simple relationship links in a vertical direction only. However, there is a need to consider a more complex scenario, horizontal relationships between departments. For example, does one departments performance measures and activities link to another departments in such a way that one department can adversely or positively affect another departments performance score. Is a department entirely in control of its own performance, are there links between departments and if so how can they be dealt with so that interactions can either be ignored or resolved.

This research has made novel changes to the QFD charts and process and as such this offers opportunity for further investigation. The Relationship matrix has used the conventional weightings (9, 3, 1) however, should a more detailed approach to the weightings be considered and therefore different numbers be used to represent the strength of the relationships. For example, Pareto analysis could be used to score the factors and determine the order, particularly if a “What” links to a significant number of “Hows”, such an approach would enable an organisation to distinguish between relationships in a less arbitrary manner. But would such a change affect the intrinsic design of the QFD system? The inclusion of the Estimated Rating value only in the SRP chart is a unique feature of the QFD charts though the addition of this value to the other chart could be further investigated and evaluated.

It is acknowledged that the four-phase approach whilst ensuring connectivity between data and maintaining linkages also means that any errors in the data will be transmitted through all the charts, on both the Data Mapping - out and Data Feedback - return phase. Therefore accuracy of data is an essential ingredient in the deployment of the QPQAP Framework. One of the strengths of the QFD chart is that it is known to facilitate communication and therefore it is anticipated that, a team approach to completion will promote accuracy within the charts. However, when it is tested in practice it may be found that an independent cross check process or similar mechanism is required in order to ensure the accuracy of the data. It is critical that the data used in the QFD charts is reliable and accurate.

The Data Feedback phase starts, in the QAP (Quality Activity Planning) chart, with the performance of the quality activities being rated so that an internal rating value can be added (or updated) on the QFD chart. A systematic scoring process has been recommended, however, this requires testing in an organisational setting. It is envisaged that organisations will need to adjust the scoring process to suit their needs however the important concept is the consistency in making the evaluations of performance and this ensures the reliability and integrity of the data. The Activity Classification System (ACS) also enables informed judgements to be made about the activities and increases the reliability of the data entered on to the QAP Chart, in terms of the type of quality activities being done as well as informing the performance judgement and validity of the targets.

The QPQAP framework, through QFD, will not provide “best” or “optimum” performance since it is target dependent which relies on company management to set appropriate challenging targets, therefore it is a management tool and only as good as those engaged in its’ deployment. Similarly, it relies on organisations to select and implement suitable quality activities and regularly review the performance against the measures, so that the Feedback element of the process can be activated. In doing so, it ensures the dynamic needs of the quality programme and company quality strategy are fulfilled and maintain momentum in the quest for improved performance.

Another opportunity for future research would be to consider the implications of under-achieving on some of the strategic quality aims and therefore quality activities and would the consequences of under-achievement cause significant business problems for the organisation. FMEA (Failure Modes and Effects Analysis) could be used to identify risks and potential disasters and therefore enable situations to be proactively managed.

Adopting QFD to deploy the QPQAP framework will provide organisations with the opportunity to develop their own quality management programme which will fulfil specific company objectives. In this way, the methodology supports the “context specific” theme (Davies and Kochhar 2002), and enables organisations to identify, over a period of time, the most suitable

quality activities. This aligns with the findings of Ketokivi and Schroeder (2004) who found evidence to show that "some practices are better suited to some strategies than others" and those of Leonard and McAdam (2004) who also found organisations have their own individual route to TQM using a variety of tools and techniques, the use of which depends on the organisation.

8.2.2 Framework Testing

The QPQAP Framework deployment process is supported by an evaluation process which reviews the QFD charts to establish the quality activity(ies) which are underperforming, therefore requiring further attention. This requires an Intervention in order to address the unsatisfactory performance. A time lag between the Intervention and its subsequent effect links to the theory that TQM is a dynamic process however the time taken to notice the effect of the Intervention (or alternative quality activity) is an area requiring further research. Tan and Platts (2004) identify that the time taken for impacts of changes should be considered when making connections between actions and outputs, though they categorise the time taken as immediate, medium or long term. In particular further research should consider how long it will take the Intervention to have an effect, and what will be the consequence of waiting too long or re-analysing the QFD charts too soon. Although it has been suggested that reviews of the QAP charts should be conducted approximately quarterly, in some cases this may be inappropriate, therefore this requires further investigation. Also the research assumes that Interventions have a positive outcome and there is an increase in performance. However, this may not be true since performance may not change or may change in a negative way for the Intervention or quality activity under scrutiny, though this will not affect the logic of the Framework or QFD process, it does need noting.

Although the QPQAP Framework has been developed in order to manage underperforming quality activities with a view to achieving long term ongoing continuous improvement, it is recognised that organisations could use the framework differently. The Framework can be used to make decisions concerning "trade-offs", for example, where resources are limited and optimum performance gains can be achieved for minimum effort. Alternatively impacts of performance changes can be evaluated so that any consequences in changes to resources can be minimised. It has been suggested (Thawesaengskulthai and Tannock 2008) organisations find it difficult to decide which CI and quality management initiatives best meet their requirements, however the QPQAP Framework could be used to compare and evaluate a selection of initiatives that organisations are engaging in. Therefore actual use of the framework by organisations, particularly in this manner, offers opportunities for further research.

The QPQAP Framework was tested to ensure quality activities could be aligned with strategic aims and to prove the evaluation and analysis methodology. The testing was completed with illustrative theoretical data, which although based on the authors' industrial experience and knowledge gleaned during the case study investigations, it is recognised that a full practical test with actual company data is essential. The testing will need to be conducted as a longitudinal case study (to enable the data feedback and review phase to occur), where the actual company selected has a strategic quality focus, uses quality activities and records suitable performance measures, and must also be willing to share sensitive data with the researcher.

The charts used for the testing process have been limited to a simple five by five grid deliberately so that the vital few, strategic quality aims and quality activities were considered. However, the effects of expanding the QFD charts could be investigated. A range of theoretical situations were created for the tests, however, it is acknowledged that this was not an exhaustive range and covered extreme situations. In addition, although two scenarios, (for each situation) relationships correct and incorrect were analysed, again, not every possible combination of incorrect relationships were tested. The testing focused on the relationships with the strongest and most complex relationships, which would therefore more likely show the impact of the error and possibly mislead the organisation. Again, more comprehensive testing concerning both individual and multiple false relationships would enhance the reliability of the findings. The production of a reliable trouble shooting system to detect relationship errors may be beneficial to organisations and offers an additional opportunity for further research. This research theme could be extended to include the development of a software system for capturing, documenting and cross checking the data, followed by relationship testing then conducting final analysis.

Despite these limitations in the testing process, when the QFD charts contained reliable accurate data which aligned with the completion guidance criteria, the quality activities, through their performance and the subsequent organisation performance measures, could be linked to the strategic quality aims of the organisation. In addition, changes in performance of the quality activities, due to Interventions, cascaded through the charts.

8.3 Activity Classification System (ACS)

The Activity Classification System (ACS) was created in order to enable organisations to better understand the actual quality activities being performed. This information, along with the time spent on the quality activities, and the associated performance measures, is the data that is used to create the QAP chart, and also inform the Internal Rating values to start the

feedback and review process. This information ensures that performance judgements are based on rigorous, reliable data. In addition, the ACS system can monitor whether Interventions are actually being applied and track the actual deployment of quality activities.

The ACS comprises a set of definitions and a framework which enables the day-to-day activities of manufacturing personnel to be classified and analysed to determine the type of quality activities participated in (Figure 8.2). Two main categories were created:

1. Embedded (day-to-day) quality activities which comprises three sub categories: compliance and control; corrective action; prevention and improvement.
2. Quality Improvement Projects.

The research established that the embedded activities are intrinsic to an individuals main job function whereas the quality improvement projects operate extrinsically to an individuals' role.

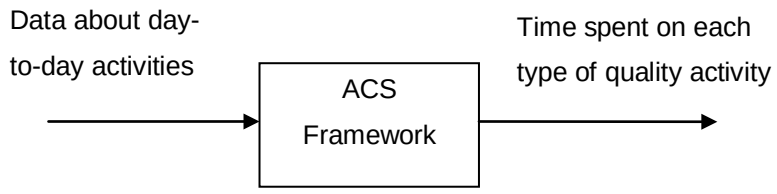


Figure 8.2 Overview of ACS

It is envisaged that this detailed knowledge can be used to maintain momentum within quality programmes to drive continuous improvement. McAdam and Lafferty (2004) found that in order to achieve goals employees needed to be empowered and have adequate provision of methods and tools to perform their job. The ACS will directly lead to the incorporation of quality activities (tools and techniques) into day-to-day jobs, and through this will support the empowerment of manufacturing personnel, as they select the most appropriate quality activities to engage in. However, the organisation will need to support employees with training and education programmes concerning the application and deployment of tools and techniques.

It was found that, unlike most literature, the definitions which emerged identified that not all quality activities were positive or proactive, and that manufacturing personnel have tasks which react to poor quality occurring and try to manage failures. These quality activities (classified as Compliance and Control or Corrective Action) generate a new set of issues for organisations to manage. For example, the data collected may reveal repeated errors, corrective actions that have not worked, too many or too few compliance/control activities, which in turn lead to increased poor performance. By recognising these activities exist, organisations through employee empowerment could manage and reduce the reactive quality activities whilst not adversely affecting quality performance. Time spent on reactive activities is time not spent on the main job function or proactive quality activities. The data obtained

from the ACS could enable organisations to understand their specific quality activities and manage them accordingly. These are opportunities for further research.

The collection of data concerning how individuals spend their time could be viewed as contentious at some organisations. A reliable and quick method is required which will enable an individual to collect and classify the data, then a system is required which can collate, manage and report this data. A sustainable long term process is necessary, not performed by an outside researcher or management as this will appear to be control/micro management and impede empowerment. Development of such a system is an opportunity for further research.

The ACS definitions and framework require further testing, in particular in a range of manufacturing organisations from different industry sectors, with different (non cellular) manufacturing systems, and a greater range of individual roles, particularly a pure operator role. If this further research validates the ACS then future research could explore its application in non manufacturing environments.

Research (Palmberg and Garvare 2006) reported that managers in a quality award winning organisation spent 25% of their time on improvement work. More recent research (Thawesaengskulthai 2010) found that three organisations which adopted improvement initiatives spent 20-80 per cent of their time on activities and also experienced initiative fatigue and difficulty in selecting, managing and implementing improvement activities. The ACS system will reveal the quality activities and time spent on them therefore providing organisations with information to enable them to manage the activities and time effectively. Further research could use the data to compare time spent on the different types of quality activities and look for country or industry sector trends. Also, more specifically, the time spent on the different types of quality activities could facilitate their management as it will reveal the level of adoption by the organisation. Time spent on quality activities may also be a measure of management commitment to quality (improvement).

The ACS has assumed a static view of the quality activities; however, given that quality activities are dynamic and activities change in order to re-energise the quality programme, then the impact of this on the ACS should be investigated. Do quality improvement projects lead to embedded day-to-day activities? Once quality activities are embedded do they remain so or do they fade? Do activities move between categories? All these questions are opportunities for further research. In order to complement the dynamic theme then a review frequency is required and this should be incorporated with the data collection and reporting system previously mentioned.

The categorisation of individuals' activities with respect to different types of quality activity has not previously been examined. The purpose of the Activity Classification System is to enable the evaluation of Interventions or quality activities, and in association with their performance measures, inform judgements about the Internal Rating values used in the QAP chart, within the QPQAP framework. In order to do this then the two frameworks need formally linking.

8.4 Combining the QPQAP Framework and ACS

The purpose of the QPQAP Framework is to enable organisations to manage their quality programmes. The ACS provides information concerning the level of participation in the different types of quality activities. The implementation of quality activities is the fundamental element in the operationalisation of the quality programme. The separate research streams found key similarities in the quality activities. The quality programme investigations (Chapter 4) established that quality activities could be divided into two main categories: project based or those embedded in the way of working. Similarly, the participant observation research and subsequent analysis (in Chapter 7) established two general categories: quality improvement projects and embedded day-to-day quality activities. This synergy at the operational level means that it is theoretically feasible to link the two different models. Therefore the QPQAP Framework and ACS have been formally linked (Figure 8.3).

This Figure (8.3) demonstrates that the output from the ACS (the information about which quality activities are performed and the proportion of time spent on them) can be used to inform the decision about the Internal Rating values in the QAP chart, when considered in conjunction with the performance measures. For example, department management may believe that a certain quality activity is being performed regularly; however, activity data from individuals within the manufacturing department may reveal that very little of the activity is actually happening. If this is assessed in parallel with the performance data, which could suggest the performance is unchanged, then together the evidence would support a low Internal Rating value being allocated. Alternatively, improved performance (without evidence of actions) may suggest that the performance has been affected by some other factors. In this case this would raise doubts about the relationships between activities and performance measures, so that the evaluator could reappraise the QAP chart. Conversely, significant use of a quality activity without an increase in performance may also suggest a potential relationship problem. In addition, this information would support the use of an Intervention or change in type of quality activity. Combining the two methods increases the rigor in the QPQAP framework as the ACS helps contextualise the data, which leads to better understanding and management of the relationships.

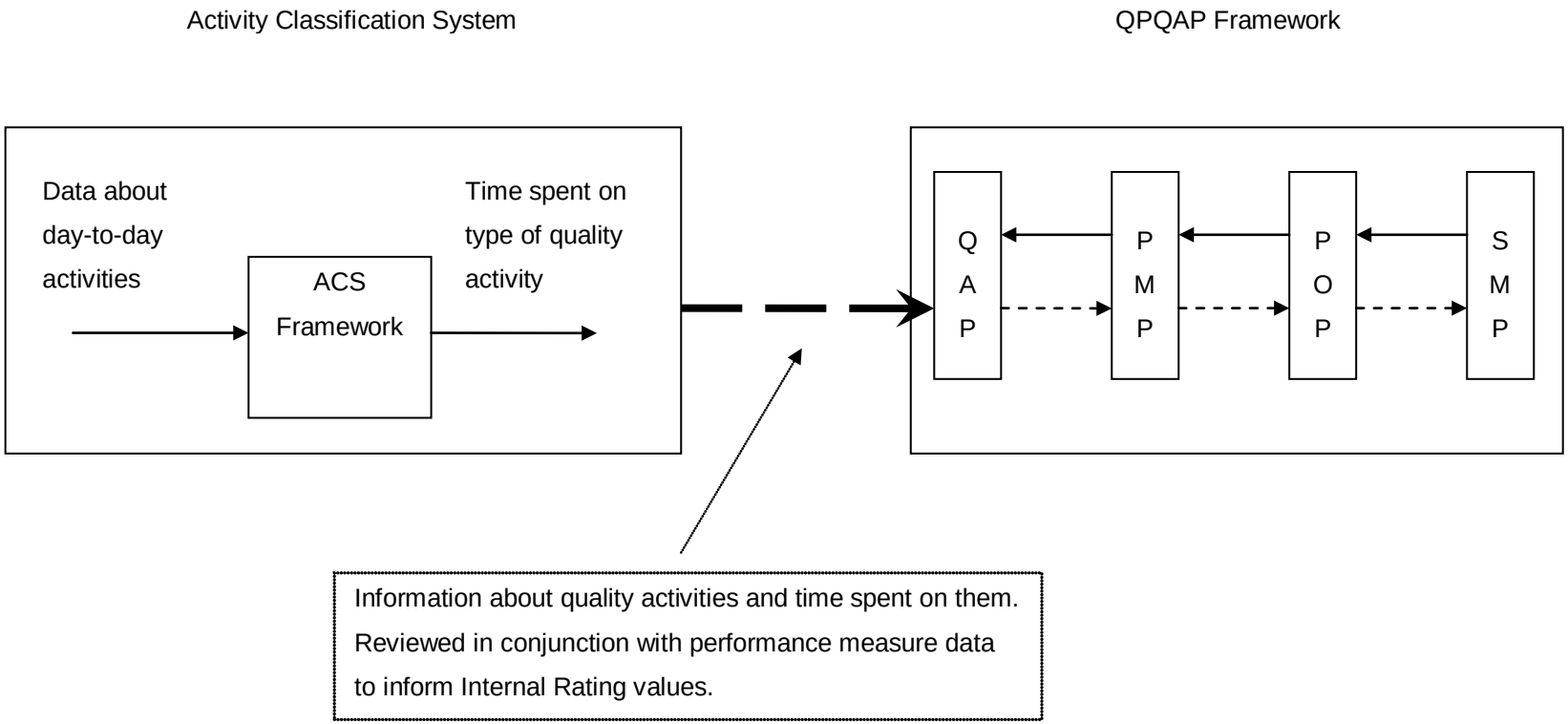


Figure 8.3 ACS Output informs QPQAP Input

It is envisaged that the combined use of these systems will enable organisations to manage their quality programmes. The QPQAP framework will enable the strategic alignment of quality activities, through performance measures, to strategic quality aims. Research (Witcher and Chau 2007) believe it is necessary that operations inform strategy and people understand strategy so it informs daily management activities. The ACS will provide data to guide the management of the quality activities (through the QAP chart) and also provide information about their execution. It is this detailed information which will enable the most suitable quality activities to become embedded into the day-to-day roles of manufacturing personnel. By linking the QAP chart to the ACS, then not only can the ACS support the judgements to the QPQAP framework, but the reverse of this relationship can be considered. The QAP chart, through the identification of quality activities can be used to guide the day-to-day actions of individuals. For example, the QAP chart may reveal a quality activity which is underperforming (and having a significant consequence on the quality aims). In this instance, then this knowledge can be used to encourage greater application and/or participation in the quality activity if insufficient time is being spent on it. It may, when reviewed in conjunction with the ACS data and further investigation, suggest that more training and development of manufacturing personnel is required. When this information is combined with that concerning the activities which are meeting performance objectives then organisations may be able to target resources at the most important activities. The combined use of the models enables quality activities to be selected and focused on top management objectives and together the models enable employees' activities to support the goals of the organisation. This aligns with research (Kumar and Antony 2008) which reported that successful quality initiatives required strong links to employees in terms of training, resources and communication. The frameworks can align quality activities towards achieving customer satisfaction through performance objectives and measures which encourage continuous improvement via the application of quality activities (tools and techniques). Recent research (Kumar *et al.* 2009) into the implementation of a quality improvement project (Six Sigma initiative) found that initiative failures were caused by the initiative not being linked to strategic business goals and measurable objectives. These authors noted that these organisations engaged in fire-fighting and insufficient training and education of employees. The proposed framework can enable organisations to overcome such issues.

The combined usage of these frameworks provides organisations with an effective method of managing their quality programme. Research has started to indicate that there is a need for this type of methodology. According to Hoogervorst *et al.* (2005) successful TQM programmes require alignment and coherence in approach between management practices, structures, systems and employee behaviour. More generally, within the generic field of Operations Management, research (Radnor and Barnes 2007) has identified a need for a coherent and connected set of performance measures linked to organisational strategy and operational activities. Fotopoulos and Psomas (2009) concluded that "quality tools alone

cannot lead a company to continuous process improvement, customer satisfaction and consolidation of its market position, without proper guidance by top management and employee and supplier support". More recently, Thawesaengskulthai (2010) identified future research is required to provide an effective way to manage improvement activities adopted and methods to sustain the improvement initiatives until they become embedded into the organisational culture then automatically sustained.

It would appear that combining the QPQAP and ACS meets these needs and it is proposed that together they form a framework to enable the management of quality programmes (Figure 8.4). This new framework brings together the features of the individual frameworks into one model.

The suggestions contained in this thesis have indicated review periods for the charts within the QPQAP Framework, and therefore, if combined with the ACS then the time dynamic must also be included. The review process is necessary to facilitate CI and sustain the improvements. Research (Bateman 2005) proposes that sustainable improvement activities firstly require contribution and buy in from shop floor personnel, supported by a use of performance measures and a focus to maintain the activities. Secondly to maximise improvements the activities require coordination, alignment with strategy (direction and goals) and senior management support and focus. The combined framework provides a structure to support both sets of requirements. The combined framework also shows an increased emphasis on the operational level of the model through the ACS which relies on increased employee involvement in the quality activities and ultimately the quality programme. The linkages between the frameworks have been extended to include all elements within the new model. It can be seen that there are upwards and downwards links between the QPQAP and ACS frameworks to show the data flows and feedback linkages in order to maintain momentum and an ongoing drive for improved performance. It demonstrates that not only does the ACS drive the QPQAP data feedback phase, but that the analysis results for the QPQAP can be used to change the quality activities (through Interventions) and therefore affect the data collected in the ACS.

In a recent interview an eminent practitioner Estelle Clark stated that "Quality enables the strategy to be translated into operations and if the operational processes aren't good enough then it helps by delivering improvement projects" she noted that "the only way to know if you're making the right changes is if this whole process is joined up" and added "quality links everything together and can make a business successful" (Russell 2010). The QPQAP and ACS provide an organisation with the means to fulfil these statements.

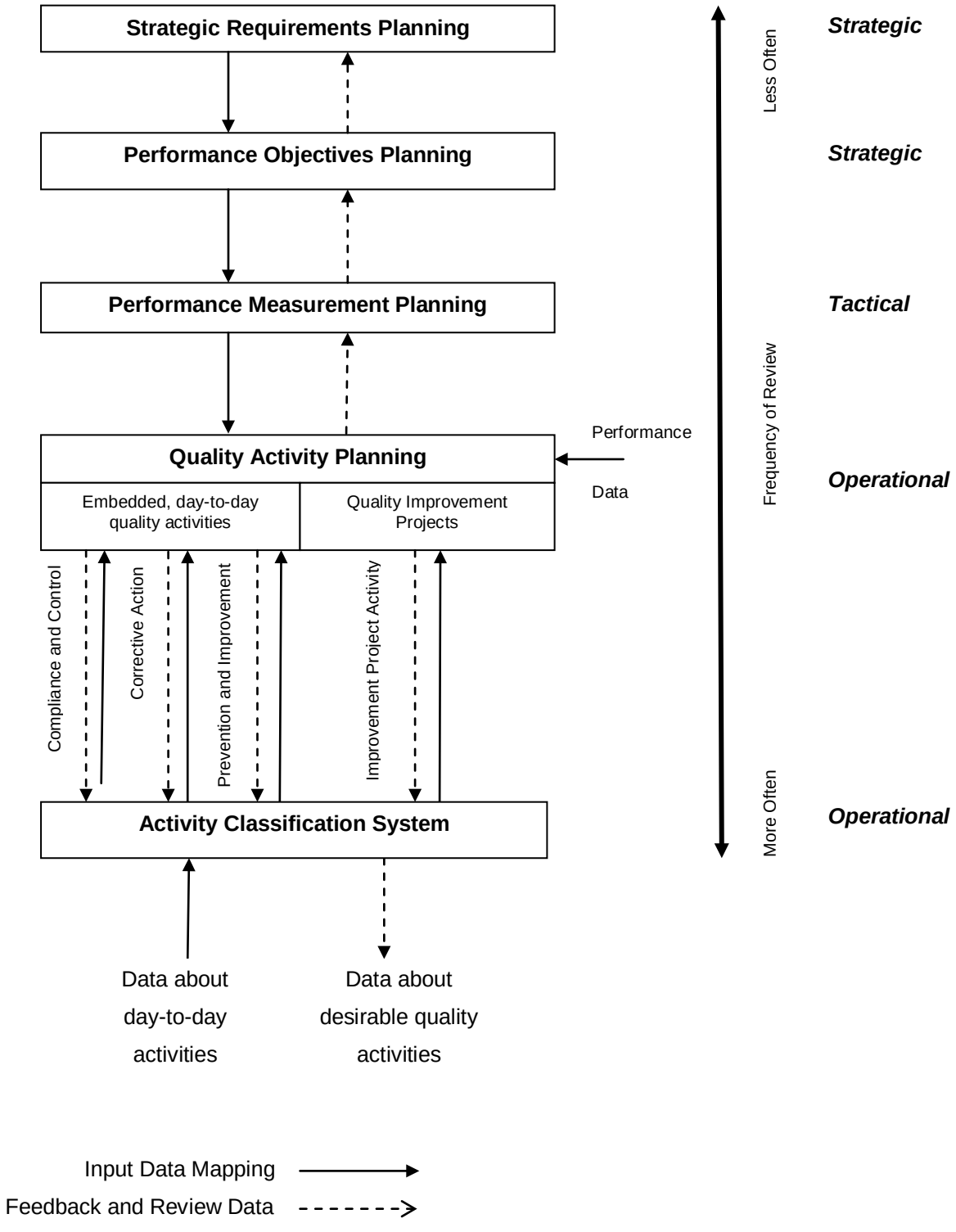


Figure 8.4 Proposed Quality Programme Management Framework

It is believed that the proposed Quality Programme Management Framework could offer organisations significant strategic, tactical and operational benefits. Therefore further research to support this suggestion by testing the proposed framework is required.

Once further research has tested and validated the proposed Quality Programme Management Framework, further extension research could explore a number of topics as a direct result of the data and new model. For example, investigations could consider:

1. Time, in terms of the amount spent of the different types of activities and how the proportion of time spent changes with levels of performance. For example, do organisations with lower levels of quality performance spend more time on Corrective action and Compliance and Control activities? Conversely, do organisations with superior quality performance spend more time on Prevention and Improvement Activities or Quality Improvement Projects?
2. Is there an investment payback for performance increases? The investment may be in terms of time spent on quality activities (as opposed to direct production activities), time and cost associated with training and education, or costs to purchase equipment to support the quality activities. Is it possible to use the Framework to link performance benefits to investments in quality activities so that organisations can make effective use of (limited) resources?
3. How the data can be used to empower individuals and enable them to review, consider or plan their day-to-day activities to incorporate new quality activities or maintain embedded ones?
4. Developing a data (knowledge) management system which can share the information between organisational levels and enable planned collection and collation of the data, formal timely reviews and managing the results of analyses so that it can be communicated and acted upon by relevant people within the organisation.

It is suggested that combining the QPQAP and ACS into a Quality Programme Management Framework has produced a model which, subject to further research, offers significant potential. It could offer organisations the ability to know the most effective quality activities to engage in, why and how they contribute to the quality performance of the organisation. This knowledge and capability could contribute to competitive advantage.

8.5 Chapter Summary

This chapter has reviewed the QPQAP Framework and the ACS from a practitioner and application perspective and commented on how they could be used individually or as a combined model. The discussion so far has indicated a number of potential opportunities for

further research and this is consistent with the methodological approach used within this research. The intention of exploratory research is to contribute to the theory development and building phases of research and as an output identify further themes requiring research by identifying tentative hypotheses. Therefore, a suitable way to summarise this chapter is by creating new hypotheses, which have been designed to cover the key themes within this discussion, and where appropriate identify supporting research objectives. These will address the frameworks individually and then combined.

QPQAP Framework: Hypothesis

The QPQAP Framework can be used by manufacturing organisations to manage and monitor the effectiveness of quality activities in achieving strategic quality requirements.

In order to fulfil this hypothesis then:

1. The QPQAP deployment process (and definitions) and analysis method requires testing with actual company data, in order to explore consequences of correct and incorrect data and relationships, the timeliness of review periods particularly with regard to a time lag following Interventions, and validation of the feedback/review process to prove the dynamic element of the framework.
2. A handbook to guide the implementation in organisations is required, which includes a mechanism for checking the accuracy of the data and a troubleshooting process for detecting incorrect relationships.
3. A comparison of implementations across different sized companies in different manufacturing sectors would increase the reliability, validity and generalisability of the framework.
4. It is suggested that the deployment process offers opportunities for further development in terms of the QFD charts used (for example should the “roof” be included) and investigation into the complexities behind some of the relationships between elements of the framework.

ACS: Hypothesis

An individual’s day-to-day activities can be managed in order to enable quality activities to be embedded into working practices and facilitate the adoption of a range of quality tools and techniques to meet organisational quality requirements.

In order to test this hypothesis then:

1. Further testing in terms of theory development: does the ACS work for a range of manufacturing roles in differing industrial sectors? This is required in order to improve the generalisability, reliability and validity of the framework.
2. A refined system for data collection, collation, reporting and management is required.
3. A guidance document is needed to enable organisations to adopt the ACS.

4. A longitudinal study examining the changes in the day-to-day quality activities which occur due to using the ACS. This should also include an examination of the relationship between the categories of quality activities and how the time spent on the different types changes with use of the ACS.

Quality Programme Management Framework (combined QPQAP and ACS) Hypotheses

Hypothesis One

The strategic quality aims through alignment with the operational quality activities can be used to manage improved quality performance in a manufacturing organisation.

Hypothesis Two:

An individuals' day-to-day activities can be managed to achieve improved quality performance for a manufacturing organisation.

These hypotheses provide a top-down and bottom-up perspective (respectively) of the same requirement to manage quality performance. Note that, before using the Quality Programme Management framework, its' components (the QPQAP and ACS) must be individually verified. These hypotheses can be explored by investigating:

1. Timely review processes which will facilitate the movement of data through the framework and maintain the dynamic process to ensure the quality programme and associated quality activities evolve to meet changing performance demands.
2. Can the new framework be used to embed quality activities into an individual's day-to-day activities and thereby increase the range of tools and techniques used?
3. Does the proportion of time spent on a quality activity correlate to quality performance levels. In particular:
    a. Does a greater time spent on Corrective Action quality activities indicate lower levels of quality performance?
    b. Does a greater time spent on Prevention and Improvement activities and Improvement projects correlate to higher levels and improvements in quality performance?
    c. Does the time spent on Compliance and Control activities affect quality performance levels so that less time results in lower performance and vice versa?
4. How can the time be managed to achieve the required quality performance and still meet other organisational demands?
5. Does engaging employees in improvement projects (outside day-to-day activities) link to identifiable improved performance?
6. Can the framework be used to manage the implementation of a quality programme, for any manufacturing organisation, including SME's?

This chapter has reviewed the proposed frameworks from a practitioner and application-based perspective and developed further hypotheses and research questions which will build on the theory development presented in this thesis.

9.0 Conclusion

The investigations in the literature review found that there was a need for a dynamic TQM model which covered the strategic, tactical and operational levels of TQM, represented through quality principles, quality practices and quality activities respectively, and defines the linkages between these levels. It was established that a mature approach to TQM (and Continuous Improvement) was characterised by a strategic approach. The quality practices comprising TQM were found to differ and reflect generic themes rather than identify specific quality activities (tools and techniques) which comprise the practice. CI, in the form of quality activities, comprising quality tools and techniques, was found to be the operationally focused aspect of TQM, designed to improve quality performance. Although employee involvement (EI) has been identified as a critical theme in TQM, specific details concerning the usage of tools and techniques by individuals within their day-to-day roles has not been explored.

TQM has been identified as still requiring theory building research and therefore exploratory case studies were selected as the primary research design method for both streams of the research investigations. Firstly, the management of company quality programmes, the quality practices and quality activities and relationships between these components was investigated using interviews, questionnaires and documentation. The data was evaluated using content analysis (including coding) and matrix displays, both at a within case and cross case level. A link between company quality programmes, quality practices and quality activities was not evident. The analysis established a mismatch between academic research and the practitioner perspective concerning quality practices, since the practitioners did not refer to the generic term ‘quality practice’ and neither did they mention the specific quality practice names. In addition data triangulation found a mismatch between the data sources when analysed to determine the extent of existence of a quality practice. Therefore a practitioner-generated link between the quality programme, quality practices and quality activities could not be found. Instead, performance objectives were identified as the mechanism by which quality programmes were driven, in contrast to the quality-orientated academic perspective which has viewed performance as an output occurring as a consequence of the activities. Quality activities, in the form of tools and techniques, are the key element of a company quality programme. These findings led to the creation of the Quality Programme Quality Activities and Performance (QPQAP) framework which links quality programme aims to quality activities, through performance objectives and measures. The second research stream used participation observation, supported by notes and documentation, to provide rich contextual data concerning the precise day-to-day activities manufacturing personnel participated in. An iterative analytic inductive approach, involving template analysis, coding and within and cross case analysis, determined that quality activities could be grouped into

two main categories: embedded day-to-day; and improvement projects. These findings resulted in the creation of the Activity Classification System (ACS).

The QPQAP Framework is a conceptual model to enable organisations to manage their quality programmes. It links the quality programme aims, to objectives, to performance measures and targets, and finally to quality activities (both project based and day-to-day quality activities). Through these components it meets the academically identified requirement to align the strategic, tactical and operational levels of a quality programme. The QPQAP Framework enables organisations to manage their quality programme and determine whether the quality activities they are using are effective and support the quality aims or whether action, through Interventions to change the quality activities, is required. The QPQAP Framework includes a feedback and review mechanism to provide a dynamic element which will facilitate and sustain CI.

Quality Function Deployment (QFD) and the Hauser and Clausing (1988) four phase technique was selected as a suitable technique to deploy the QPQAP Framework. By making novel adaptations to the QFD chart and process, and by generating a set of supporting definitions and explanations it was possible to demonstrate how a series of modified QFD charts can be used to deploy the QPQAP Framework. The deployment process consists of two phases: a data mapping – out phase where the focus is on creating the data for the charts and identifying the relationships; and a data feedback – return phase which focuses on the performance measures and management of this information against the targets. These two phases enable an organisation to populate the charts with their own data thereby fulfilling the context specific requirement of a quality programme. The deployment process was adapted so that multi-department organisations can implement the QPQAP framework.

An analysis process, consisting of QFD chart checks and an analysis chart template, which is suitable for single and multi department organisations, has been created. The testing, with theoretical data, established that the analysis process will identify which quality activities should be focused upon to improve performance. The QPQAP Framework can be used to manage quality activities in accordance with an organisation's strategic quality aims and associated performance objectives. The framework responds to changes in performance as a result of Interventions. However, the testing process determined that incorrect relationships could not always be easily detected and therefore the creation of a troubleshooting system to detect such problems would be beneficial. The testing process emphasized that the QPQAP framework data feedback phase is driven by the performance data (Internal Rating values) entered on the QAP chart. Accurate and reliable data, on which to base these judgements, is critical to the usefulness of the framework, particularly when reviewing the effectiveness of activities against the strategic quality aims. Therefore rigorous data concerning specific quality activities contributes significantly to the effectiveness of the QPQAP Framework.

The Activity Classification System (ACS) can be used by organisations to categorise the specific quality activities performed by individuals, on a day-to-day basis, as either Embedded Quality Activities (comprising Compliance and Control, Corrective Action and Prevention and Improvement categories) or Improvement Project Quality Activities. The ACS enables organisations to determine the time spent on the different categories and the specific activity within the category. This information can inform judgements concerning the application of quality activities and their effectiveness, and therefore facilitate the incorporation of quality activities into individuals' jobs.

Combining the QPQAP Framework and ACS into a Quality Programme Management Framework provides organisations with the opportunity to manage quality programmes at the strategic, tactical and operational level. By identifying relationships it provides linkages and alignment between the levels, from the strategic quality aims through performance measures (at the tactical level) to employees engaged in operational quality activities. The structure and information enables organisations to form reliable judgements about the true performance of quality activities, understand what is actually happening and make fact-based decisions concerning interventions required to improve performance and fulfil strategic quality aims. The combined model facilitates continuous improvement through the dynamic feedback process and provides a sustainable quality management programme and therefore TQM in an organisation. This exploratory research has identified further research opportunities for the QPQAP Framework, ACS and the combined Quality Programme Management Framework.

10.0 Recommendations

Two main areas have been identified as the focus for future research:

1. Model Testing and Refinement Research

- Further case studies to replicate and confirm the original analytic generalisations which led to the creation of the QPQAP Framework, particularly those concerning quality practices, should be conducted.
- The QPQAP Framework deployment process requires further research to: confirm the structure and content of the QFD charts; consider developing systems for checking QFD chart accuracy in terms of input data and relationship errors; investigate the effects of linkages and relationships between charts in multi department organisations
- The ACS and definitions require testing and validation in different industrial sectors and processes and across different individual roles within a manufacturing shop floor environment to improve the construct and external validity.

2. Model Application and Extension Studies

- A longitudinal case study is required in which the QPQAP Framework is applied. This will enable it to be tested with actual company-based data, confirm that the framework captures changes as a result of interventions and thereby prove relationships and linkages can be mapped. This study should include investigations into the time lag between intervention and effect and whether it's beneficial to conduct FMEA to identify risks associated with under-performance.
- Extensive opportunities for further research exist concerning the ACS. A survey of manufacturing shop floor personnel to evaluate the quality activity definitions and therefore increase the generalisability would be beneficial. A longitudinal study investigating ACS application particularly examining the time, activity and performance variables and associated relationships. Investigation into systems to enable: simple data collection, collation, analysis and reporting; individuals to plan their day-to-day quality activities.
- Implementation of the Quality Programme Management Framework through a longitudinal study to determine whether it can be used to align quality activities to strategic quality requirements and can be used to facilitate the selection and deployment of quality tools and techniques to achieve improved quality performance, by validating the connection of the independent frameworks. Investigate if the framework improves EI in TQM and enables sustainable CI.

References

Abdul-Aziz, Z., Chan, F.L. and Metcalfe, V. (2000) 'Quality practices in the manufacturing industry in the UK and Malaysia' *Total Quality Management* 11 (8) 1053-1064

Abdullah, M.M.B., Uli, J. and Tari, J.J. (2008) 'The influence of soft factors on quality improvement and performance: perceptions from managers' *The TQM Journal* 20 (5) 436-452

Ackroyd, S and Hughes J.A. (1992) 2nd edn. *Data collection in context*. London: Longman

Acur, N, Gertsen, F., Sun, H. and Frick, J. (2003) 'The formalisation of manufacturing strategy and its influence on the relationship between competitive objectives, improvement goals, and action plans' *International Journal of Operations and Production Management* 23 (10) 1114-1141

Adam, E.E. (1992) 'Quality Improvement as an Operations Strategy' *Industrial Management and Data Systems* 92 (4) 3-12

Adam, E.E. (1994) 'Alternative quality improvement practices and organization performance' *Journal of Operations Management* 12 27-44

Adam, E.E., Corbett, L.M., Flores, B.E., Harrison, N.J., Lee, T.S., Rho, B.H., Ribera, J., Samson, D. and Westbrook, R. (1997) 'An international study of quality improvement approach and firm performance' *International Journal of Operations and Production Management* 17 (9) 842-873

Adam, E.E., Flores, B.E. and Macias, A. (2001) 'Quality improvement practices and the effect on manufacturing firm performance: evidence from Mexico and the USA' *International Journal of Production Research* 39 (1) 43-63

Ahire, S.L., Golhar, D.Y. and Waller, M.A. (1996) 'Development and validation of TQM implementation constructs' *Decision Sciences* 27 (1) 23-

Ahmed, S. and Hassan, M. (2003) 'Surveying case investigations on application of quality management tools and techniques in SMIs' *International Journal of Quality and Reliability Management* 20 (7) 795-826

Ahn, H. (2005) 'How to individualise your balanced scorecard' *Measuring Business Excellence* 9 (1) 5-12

Akao, Y. and Mazur, G.H. (2003) 'The leading edge in QFD: past, present and future' *International Journal of Quality & Reliability Management* 20 (1) 20-35

Anderson, M. and Sohal, A.S. (1999) 'A study of relationship between quality management practices and performance in small businesses' *International Journal of Quality & Reliability Management* 16 (9)

Ang, A. (2002) 'An eclectic review of the multidimensional perspectives of employee involvement' *The TQM Magazine* 14 (3) 192-200

Antony, J., Leung, K., Knowles, G. and Gosh, S. (2002) 'Critical success factors of TQM implementation in Hong Kong industries' *International Journal of Quality and Reliability Management* 19 (5) 551-566

Aravindan, P., Devadasan, S.R. and Selladurai, V. (1996) 'A focused system model for strategic quality management' *International Journal of Quality* 13 (8) 79-96

Atkinson, H. (2006) 'Strategy implementation: a role for the balanced scorecard?' *Management Decision* 44 (10) 1441-1460

Baidoun, S. (2004) 'The implementation of TQM philosophy in Palestinian organization: a proposed non-prescriptive generic framework' *The TQM Magazine* 16 (3) 174-185

Bardoel, E.A. and Sohal, A.S. (1999) 'The role of the cultural audit in implementing quality improvement programs' *International Journal of Quality* 16 (3)

Bateman, N. (2005) 'Sustainability: the elusive element of process improvement' *International Journal of Operations and Production Management* 25 (3) 261-276

Bayazit, O. (2003) 'Total quality management (TQM) practices in Turkish manufacturing organizations' *The TQM Magazine* 15 (5) 345-350

Beecroft, D. (1999) 'The role of quality in strategic management' *Management Decision* 37 (6)

Behara, R.S and Gundersen, D.E (2001) 'Analysis of quality management practices in services' *International Journal of Quality and Reliability* 18 (6) 584-604

Beheshti, H.M. and Lollar, J.G. (2003) 'An empirical study of US SMEs using TQM' *TQM & Business excellence* 14 (8) 839-847

Bendell, T. (2000) 'What is six sigma?' *Quality World* 14-17

Bessant, J. and Francis, D. (1999) 'Developing strategic continuous improvement capability' *International Journal of Operations & Production Management* 19 (11) 1106-1119

Bessant, J., Caffyn, S., Gilbert, R., Harding, R. and Webb, S. (1994) 'Rediscovering continuous improvement' *Technovation* 14 (1) 17-29

Bicheno, J. (1998) *The Quality 60: A guide for service and manufacturing*. Buckingham: PICSIE books

Bickman, L. and Rog, D.J. (1998) *Handbook of Applied Social Research Method*s. USA: Sage Publications

Bititci, U.S., Carrie, A.S. and McDevitt, L. (1997) 'Integrated performance measurement systems: a development guide' *International Journal of Operations and Production Management* 17 (5) 522-534

Boaden, R.J. (1997) 'What is total quality management…and does it matter?' *Total Quality Management* 8 (4) 153-171

Bolden, R., Waterson, P., Warr, P., Clegg, C. and Wall, T. (1997) 'A new taxonomy of modern manufacturing practices' *International Journal of Operations and Production Management* 17 (11) 1112-1130

Brah, S.A., Tee, S.S.L. and Rao, B.M. (2002) 'Relationship between TQM and performance of Singapore companies' *International Journal of Quality & Reliability Management* 19 (4) 356-379

British Standards Institution (1992) *Guide to the Economics of Quality Part 2: Prevention, Appraisal, Failure Model*. BS6143-2: 1992. Milton Keynes: British Standards Institution

Bunney, H.S. and Dale, B.G. (1997) 'The implementation of quality management tools and techniques: a study' *The TQM Magazine* 9 (3) 183-189

Burgess, R. (1984) *In the field: An introduction to field research*. London: George Allen and Unwin. Cited in Waddington, D. (2004) 'Participant Observation' In *Essential guide to qualitative methods in organisational research.* ed by Cassell, C. and Symon, G. London: Sage, 154-164

Cagliano,R., Blackman, K. and Voss, C. (2001) 'Small firms under microscope: international differences in production/operations management practices and performance' *Integrated Manufacturing Systems* 12 (7) 469-482

Calingo, L.M.R. (1996) 'The evolution of strategic quality management' *International Journal of Quality* 13 (9) 19-37

Carpinetti, L.C.R., Buosi, T and Gerólamo, M.C. (2003) 'Quality management and improvement: A framework and a business-process reference model' *Business Process Management Journal* 9 (4) 543-554

Carpinetti, L.C.R., Gerólamo, M.C. and Dorta, M. (2000) 'A conceptual framework for deployment of strategy-related continuous improvements' *The TQM Magazine* 12 (5) 340-349

Cassell, C. and Symon, G. (2004) *Essential guide to qualitative methods in organisational research.* London: Sage

Caudell, M.J. (1997) 'The quality crusade: why industry must heed the message' *Engineering Management Journal* April 1997 83-88

Chang, H.H. and Sinclair, D.A. (2003) 'Assessing workforce perception of total quality-based performance measurement: a case study of a customer equipment servicing organization' *TQM & Business Excellence* 14 (10) 1093-1120

Chang, S., Lin, N., Yang, C. and Sheu, C. (2003) 'Quality dimensions, capabilities and business strategy: an empirical study in high-tech industry' *Total Quality Management* 14 (4) 407-421

Chapman, R.L., Murray and P.C., Mellor, R. (1997) 'Strategic quality management and financial performance indicators' *International Journal of Quality & Reliability Management* 14, (4) 432-448

Chin, K.S., Tummala, V.M.R. and Chan, K.M. (2003) 'Quality management practices in Hong Kong industries: A comparison between electronics and toys manufacturing industries' *International Journal of Quality & Reliability Management* 20 (9) 1051-1083

Choi, T.Y. and Eboch K. (1998) 'The TQM Paradox: Relations among TQM practices, plant performance, and customer satisfaction' *Journal of Operations Management* 17 1998 59-75

Clargo, M. (2004) 'The designer organisation: Organisations too can benefit from the application of design and quality tools, and with startling results!' *International Journal of Quality & Reliability Management* 21 (9) 973-983

Claver, E. and Tari, J.J. (2008) 'The individual effects of Total Quality Management on customers, people and society results and quality performance in SMEs' *Quality and Reliability Engineering International* 24 199-211

Claver, E., Tari, J.J. and Molina, J.F. (2002) 'Areas of improvement in certified firms advancing towards TQM' *International Journal of Quality and Reliability Management* 19 (8/9) 1014-1036

Cohen, L. (1995) *Quality Function Deployment: how to make QFD work for you*. Wokingham: Addison-Wesley

Cooke, G. (2010) *Case Study Report: Within Case Analysis*, Unpublished Internal Report, Coventry University, Coventry.

Cooke, G. and Goodyer, J.E. (2000) 'Improving Quality Performance of Manufacturing Personnel Through Job Activity Analysis – A Case Study-Based Framework, In *Advances in Manufacturing Technology – XIV: Proceedings of the Sixteenth National Conference on Manufacturing Research*. Bury St Edmunds & London: Professional Engineering Publishing Limited: 175-179.

Corbett, L.M. and Rastrick, K.N. (2000) 'Quality performance and organization culture: a New Zealand study' *International Journal of Quality and Reliability Management* 17 (1)

Crosby, P.B. (1979) *Quality is free: the art of making quality certain.* London: McGraw-Hill

Crowe, T.J. and Cheng, C. (1996) 'Using quality function deployment in manufacturing strategic *planning' International Journal of Operations & Production Management* 16 (4) 35-48

Curkovic, S., Melnyk, S. Calantone, R. and Handfield, R. (2000a) 'Validating the Malcolm Baldridge National Quality Award Framework through structural equation modelling' *International Journal of Production Research* 38 (4) 765-791

Curkovic, S., Vickery, S. and Droge, C. (2000) 'Quality-related action programs: Their impact on quality performance and firm performance' *Decision Sciences* 31 (4) 885-905

Curry, A. and Kadasah, N. (2002) 'Focusing on key elements of TQM – evaluation for sustainability' *The TQM Magazine* 14 (4) 207-216

Dabhilkar, M. and Bengtsson, L. (2004) 'Balanced scorecards for strategic and sustainable continuous improvement capability' *Journal of Manufacturing Technology Management* 15 (4) 350-359

Daily, B.F, and Bishop, J.W. (2003) 'TQM workforce factors and employee involvement: the pivotal role of teamwork' *Journal of Managerial Issues* 15 (4) 393-412

Dale, B.G. and Lascelles, D.M. (1997) 'Total quality management adoption: revisiting the levels' *The TQM Magazine* 9 (6) 418-428

Dale, B.G., Wu, P.Y., Zairi, M., Williams, A.R.T. and Wiele, T.V.D. (2001) 'Total quality management and theory: an exploratory study of contribution' *Total Quality Management* 12 (4) 439-449

Davies, A.J. and Kochhar, A.K. (2002) 'Manufacturing best practice and performance studies: a critique' *International Journal of Operations & Production Management* 22 (3) 289-305

Davies, E. and Isaac, A. (1998) 'A model for quality' *Manufacturing Engineer* Dec 1998 281-285

Dayton, N.A. (2003) 'The demise of total quality management (TQM)' *The TQM Magazine* 15 (6) 391-396

Dean, J.W. and Bowen, D.E. (1994) 'Management theory and total quality: improving research and practice through theory development' *Academy of Management Review* 19 (3) 392-

Denzin, N.K. (1978) 2nd edn. *The Research Act.* New York: McGraw Hill. Cited in Jick, T.D. (1979) 'Mixing qualitative and quantitative methods: triangulation in action' *Administrative Science Quarterly* 24 602-611

Dow, D., Samson, D and Ford, S. (1999) 'Exploding the myth: Do all quality management practices contribute to superior quality performance?' *Production and Operations Management* 8 (1) 1-27

Easterby-Smith, M., Thorpe, R. and Lowe, A. (2002) 2nd edn. *Management Research: an introduction.* London: Sage

Easton, G.S. and Jarrell, S.L. (1998) 'The effects of Total Quality Management on corporate performance: an empirical investigation' *Journal of Business* 71 (2) 253-307

Ebrahimpour, M. and Withers, B.E. (1992) 'Employee involvement in quality improvement: a comparison of American and Japanese manufacturing firms operating in the U.S.' *IEEE Transactions on Engineering Management* 39 (2) 142-148

Feigenbaum, A.V. (1991) 3rd edn. *Total quality control.* London: McGraw-Hill

Flick, U. (1998) *An introduction to qualitative research*. London: Sage Publications

Flynn, B.B., Sakakibara, S., Schroeder, R.G., Bates, K.A. and Flynn, E.J. (1990) 'Empirical research methods in operations management' *Journal of Operations Management* 9 (2) 250-284

Flynn, B.B., Schroeder, R. and Sakakibara, S. (1995) 'Determinants of Quality Performance in High- and Low-Quality Plants' *Quality Management Journal*, Winter 1995 8-25

Flynn, B.B., Schroeder, R.G. and Sakakibara, S. (1994) 'A framework for quality management research and an associated measurement instrument' *Journal of Operations Management* 11 1994 339-366

Forker, L.B., Vickery, S.K. and Droge, C.L.M. (1996) 'The contribution of quality to business performance' *International Journal of Operations and Production Management'* 16 (8) 44-62

Forza, C. and Filippini, R. (1998) 'TQM impact on quality conformance and customer satisfaction: A causal model' *International Journal of Production Economics* 55 1-20

Fotopoulos, C. and Psomas, E. (2009) 'The use of quality management tools and techniques in ISO 9001:2000 certified companies: the Greek case' *International Journal of Productivity and Performance Management* 58 (6) 564-580

Fotopoulos, C.B. and Psomas, E.L. (2009) 'The impact of "soft" and "hard" TQM elements on quality management results' *International Journal of Quality and Reliability Management* 26 (2) 150-163

Garvin, D.A. (1987) 'Competing on the eight dimensions of quality' *Harvard Business Review* Nov-Dec 1987 101-109

Gilgeous, M. (1997) *A framework for manufacturing excellence*. Unpublished PhD Thesis, University of Nottingham, Nottingham.

Gilgeous, V. and Gilgeous, M. (1999) 'A framework for manufacturing excellence' *Integrated Manufacturing Systems* 10 (1)

Glaser and Strauss (1967) cited in Huberman, M.A. and Miles, M.B. (1998) 'Data Management and Analysis Methods.' In *Collecting and Interpreting Qualitative Materials*. ed by Denzin, N.K. and Lincoln, Y.S. London: Sage: 179-210

Goodyer J.E. (1998) *A Cell Design Methodology to Enable People to Reach World Class Quality Levels within a Cellular Manufacturing Environment*. Unpublished PhD Thesis, Coventry University, Coventry.

Gummerson, E. (1991) *Qualitative methods in management research*. London: Sage

Handfield, R., Jayaram, J. and Ghosh, S. (1999) 'An empirical examination of quality tool deployment patterns and their impact on performance' *International Journal of Production Research* 37 (6) 1403-1426

Handfield, R.B. and Melnyk,. S.A. (1998) 'The scientific theory-building process: a primer using the case of TQM' *Journal of Operations Management* 16 321-339

Hasan, M. and Kerr, R.M., (2003) 'The relationship between total quality management practices and organisational performance in service organisations' *The TQM Magazine* 15 (4) 286-291

Hauser, J.R. and Clausing, D. (1988) 'The House of Quality' *Harvard Business Review* 66 (3) 63-73

Heady, R.B. and Smith, M. (1995) 'An empirical study of the topical differences between total quality management and quality management' *Quality Management Journal* Spring 1995 24-37

Hellsten, U. and Klefsjö, B. (2000) 'TQM management system consisting of values, techniques and tools' *The TQM Magazine* 12 (4) 238-244

Hendricks, K.B. and Singhal, V.R. (1997) 'Does implementing an effective TQM program actually improve operating performance? Empirical evidence from firms that have won quality awards' *Management Science* 43 (9) 1258-1274

Ho, D.C.K., Duffy, V.G. and Shih H.M. (2001) 'Total quality management: an empirical test for mediation effect' *International Journal of Production Research* 39 (3) 529-548

Ho, D.C.K., Duffy, V.G. and Shih, H.M. (1999) 'An empirical analysis of effective TQM implementation in the Hong Kong electronics manufacturing industry' *Human Factors and Ergonomics in Manufacturing* 9 (1) 1-25

Ho, S.K.M and Fung, C.K.H. (1994) 'Developing a TQM excellence model' *The TQM Magazine* 6 (6) 24-30

Hoogervorst, J.A.P., Koopman, P.L. and Flier, H.v.d. (2005) 'Total quality management: The need for an employee-centred, coherent approach' *The TQM Magazine* 17 (1) 92-106

Huberman, M.A. and Miles, M.B. (1998) 'Data Management and Analysis Methods.' In *Collecting and Interpreting Qualitative Materials*. ed by Denzin, N.K. and Lincoln, Y.S. London: Sage: 179-210

Hunt, R. (2000) *Hoshin*, Transactions of the 12th Symposium on QFD, QFD Institute, Novi, MI. Cited in Akao, Y. and Mazur, G.H. (2003) 'The leading edge in QFD: past, present and future' *International Journal of Quality & Reliability Management* 20 (1) 20-35

Hunt, R.A. and Xavier, F.B. (2003) 'The leading edge in strategic QFD' *International Journal of Quality & Reliability Management* 20 (1) 56-73

Hyland, P., Mellor, R., O'Mara, E. and Kondepudi, R. (2000) 'A comparison of Australian firms and their use of continuous improvement tools' *The TQM Magazine* 12 (2)

Idris, M.A. and Zairi, M. (2006) 'Sustaining TQM: A Synthesis of Literature and Proposed Research Framework' *Total Quality Management* 17 (9) 1245-1260

Ingle, S. (2000) 'An empirical investigation of approaches to new work practices' *The TQM Magazine* 12 (6) 422-431

Irani, Z., Sharp, J.M. and Kagioglou, M. (1997) 'Improving business performance through developing a corporate culture' *The TQM Magazine* 9 (3)

Jackson, S. (1999) 'Achieving a culture of continuous improvement by adopting the principles of self-assessment and business excellence' *International Journal of Health Care Quality Assurance* 12 (2)

Jha, S., Michela, J. and Noori, H. (1999) 'Within the Canadian boundaries: a close look at Canadian industries implementing continuous improvement' *The TQM Magazine* 11 (3)

Jick, T.D. (1979) 'Mixing qualitative and quantitative methods: triangulation in action' *Administrative Science Quarterly* 24 602-611

Johanson, U., Skoog, M., Backland, A. and Almqvist, R. (2006) 'Balancing dilemmas of the balanced scorecard' *Accounting, Auditing & Accountability Journal* 19 (6) 842-857

Joseph, I.N., Rajendran C. and Kamalanabhan, T.J. (1999) 'An instrument for measuring total quality management implementation in manufacturing-based business units in India' *International Journal of Production Research* 37 (10) 2201-2215

Juran, J.M. and Gryna, F.M. (1993) 3rd edn. *Quality planning and analysis: from product development through use*. London: McGraw-Hill

Kanji, G.K. and Asher, M. (1996) *100 Methods for Total Quality Management*. London: Sage Publications

Kanji, G.K. and Sá, P.M.E. (2002) 'Kanji's Business Scorecard' *Total Quality Management* 13 (1) 13-27

Kaplan, R.S. and Norton D.P. (2000) 'Having trouble with your strategy? Then map it' *Harvard Business Review* Sept-Oct 2000 167-176

Kaplan, R.S. and Norton, D.P. (1992) 'The Balanced Scorecard – Measures That Drive Performance' *Harvard Business Review* Jan-Feb 1992 71-79

Kaplan, R.S. and Norton, D.P. (1996) 'Using the Balanced Scorecard as a Strategic Management System' *Harvard Business Review* Jan-Feb 1996 75-85

Karia, N. and Asaari, M.H.A.H. (2006) 'The effects of total quality management practices on employees' work-related attitudes' *The TQM Magazine* 18 (1) 30-43

Karuppusami, G. and Gandhinathan, R. (2006) 'Pareto analysis of critical success factors of total quality management: a literature review and analysis' *The TQM Magazine* 18 (4) 372-385

Kaynak, H., (2003) 'The relationship between total quality management practices and their effects on firm performance' *Journal of Operations Management* 21 (4) 405-435

Kehoe D.F., (1996) *The Fundamentals of Quality Management*, Chapman Hall, London, 1996.

Ketokivi, M. and Schroeder, R. (2004) 'Manufacturing practices, strategic fit and performance: A routine-based view' *International Journal of Operations & Production Management* 24 (2) 171-191

Killen, C.P., Walker, M. and Hunt, R.A. (2005) 'Strategic planning using QFD' *International Journal of Quality & Reliability Management* 22 (1) 17-29

King, N. (2004) 'Using templates in the thematic analysis of text.' In *Essential guide to qualitative methods in organisational research.* ed. By Cassell, C. and Symon, G. London: Sage: 256-270

Kirwan, B. and Ainsworth, L.K. (1993) *A Guide to Task Analysis*. London: Taylor and Francis

Klefsjö, B., Bergquist, B. and Gargave, R. (2008) 'Quality management and business excellence, customers and stakeholders: Do we agree on what we are talking about, and does it matter?' *The TQM Journal* 20 (2) 120-129

Krüger, V. (2001) 'Main schools of TQM: "the big five" *The TQM Magazine* 13 (3) 146-155

Kumar, M. and Antony, J. (2008) 'Comparing the quality management practices in UK SMEs' *Industrial Management & Data Systems* 108 (9) 1153-1166

Kumar, M., Antony, J. and Douglas, A. (2009) 'Does size matter for Six Sigma implementation?: Findings from the survey in UK SMEs' *The TQM Journal* 21 (6) 623-635

Kumar, V., Choisne, F., Grosbois, D.D. and Kumar, U. (2009) 'Impact of TQM on company's performance' *International Journal of Quality & Reliability Management* 26 (1) 23-37

Lagrosen, S. and Lagrosen, Y. (2003) 'Quality configurations: a contingency approach to quality management' *International Journal of Quality & Reliability Management* 20 (7) 759-773

Lam, S.S.K. (1996) 'Applications of quality improvement tools in Hong Kong: an empirical analysis' *Total Quality Management & Business Excellence* 7 (6) 675-680

Larson, P.D. and Sinha, A. (1995) 'The TQM impact: a study of quality managers' perceptions' *Quality Management Journal* Spring 1995 53-66

Lau, H.C. and Idris, M.A. (2001) 'The soft foundation of the critical success factors on TQM implementation in Malaysia' *The TQM Magazine* 13 (1) 51-62

Lau, R.S.M. and Anderson, C.A. (1998) 'A three-dimensional perspective of total quality management' *International Journal of Quality and Reliability Management* 15 (1) 85-98

Lawler, E.E. III, Mohrman, S.A., and Ledford, G.E. (1992) *Employee Involvement in Total Quality Management: Practices and Results in Fortune 1000 Companies.* San Francisco CA: Jossey-Bass cited in Sumukadas, N. (2006) 'Employee involvement: a hierarchical conceptualisation of its effect on quality' *International Journal of Quality and Reliability Management* 23 (2) 143-161

Lawler, E.E. III, Mohrman, S.A., & Ledford, G.E. (1995) *Creating High Performance Organizations: Employee Involvement and Total Quality Management.* San Francisco CA: Jossey-Bass cited in Sumukadas, N. (2006) 'Employee involvement: a hierarchical conceptualisation of its effect on quality' *International Journal of Quality and Reliability Management* 23 (2) 143-161

Lee, C.C., Lee, T.S. and Chang, C. (2001) 'Quality/productivity and company performance in China' *International Journal of Quality and Reliability* 18 (6) 604-625

Lee, P.M. (2002) 'Sustaining business excellence through a framework of best practices in TQM' *The TQM Magazine* 14 (3) 142-149

Lee, R.G. and Dale, B.G. (1998) 'Policy deployment: an examination of the theory' *International Journal of Quality & Reliability Management* 15 (5) 520-540

Leonard, D. and McAdam, R. (2002a) 'The strategic placement of TQM in the organisation: a grounded study' *Managing Service Quality* 12 (1) 43-53

Leonard, D. and McAdam, R. (2002b) 'Developing strategic quality management: a research agenda' *Total Quality Management* 13 (4) 507-522

Leonard, D. and McAdam, R. (2002c) 'The strategic impact and implementation of TQM' *The TQM Magazine* 14 (1) 51-60

Leonard, D. and McAdam, R. (2003) 'An evaluative framework for TQM dynamics in organisations' *International Journal of Operations & Production Management* 23 (6) 25-44

Leonard, D. and McAdam, R. (2004) 'Total quality management in strategy and operations: dynamic grounded models' *Journal of Manufacturing Technology Management* 15 (3) 254-266

Leonard, D., Reid, R. and McAdam, R. (2002) 'A grounded multi-model framework for TQM dynamics' *International Journal of Quality & Reliability Management* 19 (6) 710-736

Lewis, W.G., Pun, K.F. and Lalla, T.R.M. (2006) 'Empirical investigation of the hard and soft criteria of TQM in ISO 9001 certified small and medium-sized enterprises' *International Journal of Quality and Reliability Management* 23 (8) 964-985

Lockamy, A. (1998) 'Quality-focused performance measurement systems: a normative model' *International Journal of Operations & Production Management* 18 (8) 740-766

Madu, C.N. (1998) 'An empirical assessment of quality: research considerations' *International Journal of Quality Science* 3 (4)

Madu, C.N., Kuei, C. and Jacob, R.A. (1996) 'An empirical assessment of the influence of quality dimensions on organizational performance' *International Journal of Production Research* 34 (7) 1943-1962

Mann, R. S. (1992) *The development of a framework to assist in the implementation of TQM.* Unpublished PhD Thesis, University of Liverpool, Liverpool.

Mann, R. and Kehoe, D. (1994) 'An evaluation of the effects of quality improvement activities on business performance' *International Journal of Quality & Reliability Management* 11 (4)

Mann, R. and Kehoe, D. (1995) 'Factors affecting the implementation and success of TQM' *International Journal of Quality & Reliability Management* 12 (1)

Marr, B. and Schiuma, G. (2003) 'Business performance measurement – past, present and future' *Management Decision* 41 (8) 680-687

Martinez-Lorente, A.R., Dewhurst, F. and Dale, B.G. (1998) 'Total quality management: origins and evolution of the term' *The TQM Magazine* 10 (5) 378-386

Mavroidis, V., Toliopoulou, S. and Agoritsas, C. (2007) 'A comparative analysis and review of national quality awards in Europe: Development of critical success factors' *The TQM Magazine* 19 (5) 454-467

McAdam, R. (2000) 'Three leafed clover?: TQM, organisational excellence and business improvement' *The TQM magazine* 12 (5) 314-320

McAdam, R. and Bailie, B. (2002) 'Business performance measures and alignment impact on strategy' *International Journal of Operations and Production Management* 22 (9) 972-996

McAdam, R. and Leonard, D. (2005) 'Cross-mapping strategic and quality processes: a best practice analysis' *International Journal of Process Management and Benchmarking* 1 (1) 25-44

McCutcheon, D.M. and Meredith, J.R. (1993) 'Conducting case study research in operations management' *Journal of Operations Management* 11 239-256

McGee, E.C. and Tolchinsky, P.D. (1993) 'The convergence of total quality and work design' *Journal for Quality and Participation* March 90-96

McQuater, R.E., Scurr, C.H., Dale, B.G. and Hillman, P.G. (1995) 'Using quality tools and techniques successfully' *The TQM Magazine* 7 (6) 37-42

Mehra, S. and Agrawal, S.P. (2003) 'Total quality as a global competitive strategy' *International Journal of Quality and Reliability Management* 20 (9) 1009-1025

Mehra, S., Hoffman J.M. and Sirias, D. (2001) 'TQM as a management strategy for the next millennia' *International Journal of Operations & Production Management* 21 (5/6) 855-876

Miles, M.B. and Huberman, A.M. (1994) 2nd edn. *Qualitative data analysis: an expanded sourcebook*. USA: Sage Publications

Millar, I. (1999) 'Performance improvement. Part 2' *Industrial Management & Data Systems* 99 (6) 257-265

Montes, J.L., Jover, A.V. and Fernández, L.M.M. (2003) 'Factors affecting the relationship between total quality management and organizational performance' *International Journal of Quality & Reliability Management* 20 (2) 189-209

Morrow, P.C. (1997) 'The measurement of TQM principles and work-related outcomes' *Journal of Organisational Behaviour* 18 (4) 363-376

Motwani, J.G., Mahmoud, E. and Rice, G. (1994) 'Quality practices of Indian organisations' *International Journal of Quality and Reliability Management,* 11 (1) 38-52

Motwani, J. (2001) 'Critical factors and performance measure of TQM' *The TQM Magazine* 13 (4) 292-300

Motwani, J. (2001) 'Critical factors and performance measure of TQM' *The TQM Magazine* 13 (4) 292-300

Najmi, M. and Kehoe, D.F. (2001) 'The role of performance measurement systems in promoting quality development beyond ISO 9000' *International Journal of Operations and Production Management* 21 (1/2) 159-172

Oakland, J. (2000) 2nd edn. Total Quality Management: Text with cases. Oxford: Butterworth-Heinemann

Ooi, K.B., Arumugam, V., Safa, M.S. and Bakar, N.A. (2007) 'HRM and TQM: association with job involvement' *Personnel Review* 36 (6) 939-962

Ooi, K.B., Arumugam, V., Teh, P.L. and Chong, A.Y.L. (2008) 'TQM practices and its association with production workers' *Industrial Management and Data Systems* 108 (7) 909-927

Palmberg, K. and Garvare, R. (2006) 'Sustained quality management: how to receive the Swedish quality award twice' *International Journal of Quality & Reliability Management* 23 (1) 42-59

Patton, M.Q. (1990) 2nd edn. *Qualitative evaluation and research methods*. London: Sage

Powell, T.C. (1995) 'Total quality management as competitive advantage: a review and empirical study' *Strategic Management Journal* 16 15-37

Prajogo, D.I. and Brown, A. (2006) 'Approaches to adopting quality in SMEs and the impact on quality management practices and performance' *Total Quality Managemen*t 17 (5) 555-566

Prajogo, D.I. and Sohal, A.S. (2003) 'The relationship between TQM practices, quality performance, and innovation performance' *International Journal of Quality & Reliability Management* 20 (8) 901-918

Prajogo, D.I. and Sohal, A.S. (2004) 'The sustainability and evolution of quality improvement programmes – an Australian case study' *Total Quality Management* 15 (2) 205-220

Pun, K.F. and Gill, R. (2002) 'Integrating EI/TQM efforts for performance improvement: a model' *Integrated Manufacturing Systems* 13 (7) 447-458

Pun, K.F., Chin, K.S. and Gill, R. (2001) 'Determinants of employee involvement practices in manufacturing enterprises' *Total Qualtiy Management* 12 (1) 95-109

Quazi, H.A., Jemangin, J., Kit, L.W. and Kian, C.L. (1998) 'Critical factors in quality management and guidelines for self assessment' *Total Quality Management* 9 (1) 35-55

Radnor, Z.J. and Barnes, D. (2007) 'Historical analysis of performance measurement and management in operations management' *International Journal of Productivity and Performance Management* 56 (5/6) 384-396

Rao, S.S., Solis, L.E. and Raghunathan, T.S. (1999) 'A framework for international quality management research: Development and validation of a measurement instrument' *Total Quality Management* 10 (7) 1047-1075

Reames, J.M. (1998) 'Internal assessment methodologies: the ubiquity and usefulness of the Baldridge criteria' *International Journal of Quality Science* 3 (4)

Reeves, C.A. and Bednar, D.A. (1994) 'Defining quality: Alternatives and implications' *Academy of Management* 19 (3) 419-

ReVelle, J.B., Moran, J.W and Cox, C.A. (1998) *The QFD Handbook*. Chichester: Wiley

Ritchie, L. and Dale, B.G. (2000) 'Self-assessment using the business excellence model: a study of practice and process' *International Journal of Production Economics* 66 (3) 241-254

Ross, J. (1993) *Total Quality Management: Text Cases and Readings,* St. Lucie Press, Delray Beach, FL. Cited in Powell, T.C. (1995) 'Total quality management as competitive advantage: a review and empirical study' *Strategic Management Journal* 16 15-37

Russell, S.J. (2010) 'The lifelines interview: Estelle Clark' *Quality World* January 2010 16-17

Sadikoglu, E. (2005) 'Integration of work measurement and total quality management' *Total Quality Management* 16 (5) 597-605

Samson, D and Terziovski, M. (1999) 'The relationship between total quality management practices and operational performance' *Journal of Operations Management* 17 1999 393-409

Saraph, J.V., Benson, P.G. and Schroeder, R.G. (1989) 'An instrument for measuring the critical factors of quality management' *Decision Sciences* 20 Pt.4 Fall 810-829

Sharma, B. and Gadenne, D. (2001) 'An investigation of the perceived importance and effectiveness of quality management approaches' *Total Quality Management* 13 (6) 433-445

Sharma, M. and Kodali, R. (2008) 'TQM implementation elements for manufacturing excellence' *The TQM Magazine* 20 (6) 599-621

Shen, X.X., Tan, K.C. and Xie, M. (2000) Benchmarking in QFD for quality improvement' *Benchmarking: An International Journal* 7 (4) 282-291

Shillito, M.L. (1994) *Advanced QFD: linking technology to market and company needs*. Chichester: Wiley

Sila, I. and Ebrahimpour, M. (2002) 'An investigation of the total quality management survey based research published between 1989 and 2000' *International Journal of Quality & Reliability Management* 19 (7) 902-970

Sila, I. and Ebrahimpour, M. (2005) 'Critical linkages among TQM factors and business results' *International Journal of Operations & Production Management* 25 (11) 1123-1155

Silos, I.M. (1999) 'Employee involvement – a component of total quality management' *Production and Inventory Management Journal* 40 (1) 56-65

Sim, K.L. (2001) 'An empirical examination of successive incremental improvement techniques and investment in manufacturing technology' *International Journal of Operations and Production Management* 21 (3) 373-399

Sinclair, D. and Zairi, M. (2001) 'An empirical study of key elements of total quality-based performance measurement systems: a case study approach in the service industry sector' *Total Quality Management* 12 (4) 535-550

Siow, C.H.R, Yang, J.B. and Dale B.G. (2001) 'A new modeling framework for organizational self-assessment development and application' *Quality Management Journal* 8 (4) 34-47

Smither, R.D. (1998) 3rd edn. *The Psychology of Work and Human Performance*. England: Longman

Sohal, A.S. and Lu, E. (1998) 'Continuous quality improvements in a high-technology manufacturing environment' *International Journal of Technology Management* 16 (4/5/6) 336-357

Sousa, S.D., Aspinwall, E., Sampaio, P.A and Rodrigues, A.G. (2005) 'Performance Measures and Quality Tools in Portuguese Small and Medium Enterprises: Survey Results' *Total Quality Management* 16 (2) 277-307

Srinidhi, B. (1998) 'Strategic quality management' *International Journal of Quality Science* 3 (1) 38-70

Stading, G.L. and Vokurka, R.J. (2003) 'Building quality strategy content using the process from national and international quality awards' *TQM & Business Excellence* 14 (8) 931-946

Stone, C.L. and Banks, J.M. (1997) 'The use of customer- and employee-based performance measures in *The Times* top 500 companies' *The TQM Magazine* 9 (2)

Sumukadas, N. (2006) 'Employee involvement: a hierarchical conceptualisation of its effect on quality' *International Journal of Quality and Reliability Management* 23 (2) 143-161

Sun, H. (2000) 'Total quality management, ISO 9000 certification and performance improvement' *International Journal of Quality and Reliability Management* 17 (2)

Sun, H., Hui, I.K., Tam, AY.K. and Frick, J. (2000) 'Employee involvement and quality management' *The TQM Magazine* 12 (5) 350-354

Tan, K.C. (2002) 'A comparative study of 16 national quality awards' *The TQM Magazine* 14 (2) 165-171

Tan, K.H. and Platts, K. (2004) 'The connectance model revisited: a tool for manufacturing objective deployment' *Journal of Manufacturing Technology Management* 15 (2) 131-143

Tegarden, L.F., Sarason,Y. and Banbury, C. (2003) 'Linking strategy processes to performance outcomes in dynamic environments: the need to target multiple Bull's Eyes' *Journal of Managerial Issues* 15 (2) 133-153

Tena, A.B.E., Llusar, J.C.B. and Puig, V.R. (2001) 'Measuring the relationship between total quality management ad sustainable competitive advantage: A resource-based view' *Total Quality Management* 12 (7/8) 932-938

Thawesaengskulthai, N. (2010) 'An empirical framework for selecting quality management and improvement initiatives' *International Journal of Quality & Reliability Management* 27 (2) 156-172

Thawesaengskulthai, N. and Tannock, J.D.T. (2008) 'Pay-off selection criteria for quality and improvement initiatives' *International Journal of Quality & Reliability Management* 25 (4) 366-382

Thiagaragan, T., Zairi, M. and Dale, B.G. (2001) 'A proposed model of TQM implementation based on an empirical study of Malaysian industry' *International Journal of Quality & Reliability Management* 18 (3) 289-306

Toni, A.D. and Tonchia, S. (2001) 'Performance measurement systems – Models, characteristics and measures' *International Journal of Operations and Production Management* 21 (1/2) 46-71

Tonnessen, T. (2005) 'Continuous improvement through company wide employee participation' *The TQM Magazine* 17 (2) 195-207

Trump M.R., Utilising Performance Engineering and Design to Deploy TQM, *Proceedings 44th International Industrial Engineering Conference*, 10-18, 1993.

Tummala, V.M.R. and Tang, C.L. (1996) 'Strategic quality management, Malcolm Baldrige and European quality awards and ISO 9000 certification' *International Journal of Quality* 13 (4) 8-38

van der Wiele T., Dale, B. and Willams, R. (2000) 'Business improvement through quality management systems' *Management Decision* 38 (1) 19-23

van der Wiele, T. and Brown, A. (2002) 'Quality management over a decade' *International Journal of Quality & Reliability Management* 19 (5) 508-523

Venkateswarlu, P. and Nilakant, V. (2005) 'Adoption and Persistence of TQM Programmes – Case Studies of Five New Zealand Organisations' *Total Quality Management* 16 (7) 807-825

Vouzas, F. (2004) 'H.R. utilization and quality improvement: the reality and the rhetoric – the case of Greek industry' *The TQM Magazine* 16 (2) 125-135

Waddington, D. (2004) 'Participant Observation' In *Essential guide to qualitative methods in organisational research.* ed by Cassell, C. and Symon, G. London: Sage, 154-164

Walden, J. (2003) 'Performance excellence: a QFD approach' *International Journal of Quality & Reliability Management* 20 (1) 123-133

Walker, M. (2002) 'Customer-driven breakthroughs using QFD and policy deployment' *Management Decision* 40 (3) 248-256

White, G.P., (1996) 'A survey and taxonomy of strategy-related performance measures for manufacturing' International *Journal of Operations and Production Management* 16 (3) 42-61

Wickens, P. (1993) 'Steering the Middle Road to Car Production' *Personnel Management* June 1993 34-38

Witcher, B. (2002) 'Hoshin kanri: a study of practice in the UK' *Managerial Auditing Journal* 17 (7) 390-396

Witcher, B.J. and Chau, V.S. (2007) 'Balanced scorecard and *hoshin kanri*: dynamic capabilities for managing strategic fit' *Management Decision* 45 (3) 518-538

Witcher, B.J., Chau, V.S. and Harding, P. (2008) 'Dynamic capabilities: top executive audits and *hoshin kanri* at Nissan South Africa' *International Journal of Operations of Production Management* 28 (6) 540-561

Yeh, Y.J. (2003) 'Implementing a sustainable TQM system: employee focus' *The TQM Magazine* 15 (4) 257-265

Yin, R.K. (1994) 2nd edn. *Case study research: design and methods*. USA: Sage Publications, Inc.

Yin, R.K. (2009) *Case study research: design and methods*. USA: Sage Publications, Inc.

Yusof, S.M. and Aspinwall, E. (2001) 'Case Studies on the implementation of TQM in the UK automotive SMEs' *International Journal of Quality & Reliability Management* 18 (7) 722-744

Zairi, M. (1999) 'Managing excellence: policy and strategy' *The TQM Magazine* 11 (2) 74-79

Zhang, Q. (2001) 'Quality dimensions, perspectives and practices' *International Journal of Quality and Reliability Management* 18 (7) 708-722

Zhang, Z. (2000) 'Developing a model of quality management methods and evaluating their effects on business performance' *Total Quality Management* 11 (1) 129-137

Bibliography

Abdel-Maksoud, A.B. (2004) 'Manufacturing in the UK: contemporary characteristics and performance indicators' *Journal of Manufacturing Technology Management* 15 (2) 155-171

Amaratunga, D. and Baldry, D. (2002) 'Moving from performance measurement to performance management' *Facilities* 20 (5/6) 217-223

Amaratunga, D., Baldry, D. and Sarshar, M. (2001) 'Process improvement through performance measurement: the balanced scorecard methodology' *Work Study* 50 (5) 179-188

Bendell, T. and Marra, T. (2002) 'Six Sigma Analysed' *Quality World* April 16-18

Benson, P.G, Saraph, J.V. and Schroeder, R.G. (1991) 'The effects of organizational context on quality management: an empirical investigation' *Management Science* 37 (9) 1107-1124

Black, S.A. and Porter, L.J. (1996) 'Identification of the critical factors of TQM' *Decision Sciences* 27 (1) 1-

Bourne, M., Neely, A., Platts, K. and Mills, J. (2002) 'The success and failure of performance measurement initiatives: perceptions of participating managers' *International Journal of Operations and Production Management* 22 (11) 1288-1310

Cerio, J.M.D. (2003) 'Factors relating to the adoption of quality management practices: an analysis for Spanish manufacturing firms' *Total Quality Management* 14 (1) 25-44

Chapman, R.L. and Sloan, T.R. (1999) 'Large firms versus small firms – do they implement CI the same way?' *The TQM Magazine* 11 (2)

Claver, E., Tari, J.J. and Molina J.F. (2003) 'Critical factors and results of quality management: an empirical study' *Total Quality Management* 14 (1) 91-118

Cruise O Brien, R. (1995) 'Employee involvement in performance improvement' *Employee Relations* 17 (3) 110-120

Curkovic, S., Vickery, S.K. and Droge, C. (2000) 'An empirical analysis of the competitive dimensions of quality performance in the automotive supply industry' *International Journal of Operations and Production Management* 20 (3) 386-403

Dahlgaard, J.J. and Dahlgaard-Park, S.M. (2006) 'Lean production, six sigma quality, TQM and company culture' *The TQM Magazine* 18 (3) 263-281

Dimitriades, Z. (2000) ‘Total Involvement in quality management’ *Team Performance Management: An International Journal* 6 (7/8) 117-121

Fryer, K.J., Antony, J. and Douglas, A. (2007) ‘Critical success factors of continuous improvement in the public sector’ *The TQM Magazine* 19 (5) 497-517

Fynes, B. and Voss, C. (2001) ‘A path analytic model of quality practices, quality performance, and business performance’ *Production and Operations Management* 10 (4) 494-513

Garcia-Lorenzo, A., Prado, J.C.P. and Arca, J.G. (2000) ‘Continuous improvement and employee participation in SME’s’ *The TQM Magazine* 12 (4) 290-294

Ghalayini, A.M. and Noble, J.S. (1996) ‘The changing basis of performance measurement’ *International Journal of Operations and Production Management* 16 (8) 63-80

Ghorpade, J., Chen, M.M and Caggiano, J. (1995) ‘Creating quality-driven performance appraisal systems’ *The Academy of Management Executive* 9 (1) 32

Gomes, C.F., Yasin, M.M. and Lisboa, J.V. (2004) ‘A literature review of manufacturing performance measures and measurement in an organizational context: a framework and direction for future research’ *Journal of Manufacturing and Technology Management* 15 (6) 511-530

Hackman, J.R. and Wageman, R. (1995) ‘Total quality management: empirical, conceptual and practical issues’ *Administrative Science Quarterly* 40 (1995) 309-342

Hammersley, G. and Pinnington, A. (1999) ‘Employee response to continuous improvement groups’ The TQM Magazine 11 (1)

Hansson, J. and Klefsjo, B. (2003) ‘A core value model for implementing total quality management in small organisations’ *The TQM Magazine* 15 (2) 71-81

Herrman, A., Huber, F., Algesheime, R. and Tomczak, T. (2006) ‘An empirical study of quality function deployment on company performance’ *International Journal of Quality and Reliability Management* 23 (4) 345-366

Jabnoun, N. (2001) ‘Values underlying continuous improvement’ *Total Quality Management* 13 (6) 381-388

Joseph, I.N., Rajendran, C., Kamalanabhan, T.J. and Anantharaman, R.N. (1999) ‘Organisational factors and total quality management – an empirical study’ *International Journal of Production Research* 37 (6) 1337-1352

Kaplan, R.S. and Norton, D.P. (1993) 'Putting the balanced scorecard to work' *Harvard Business Review* September-October 134-147

Kondo, Y. (1998) 'Hoshin Kanri – a participative way of quality management in Japan' *The TQM Magazine* 10 (6)

Kumar, V. De Grosbois, D. Choisne, F and Kumar, U. (2008) 'Performance measurement by TQM adopters' *The TQM Journal* 20 (3) 209-222

Lalla, T.R.M., Lewis, W.G., Pun, K.F., Chin, K.S. and Lau, H.C.W. (2003) 'Manufacturing strategy, total quality management and performance measurement: an integrated model' *International Journal of Manufacturing Technology and Management* 5 (5/6) 414-427

Lu, M.H. and Kuei, C.H. (1995) 'Strategic marketing planning: a quality function deployment approach' *International Journal of Quality and Reliability Management* 12 (6) 85-96

Maani, K.E., Putterill, M.S. and Sluti, D.G. (1994) 'Empirical analysis of quality improvement in manufacturing' *International Journal of Quality and Reliability Management* 11 (7)

Martins, A. and Aspinwall, E.M. (2001) 'Quality function deployment: an empirical study in the UK' *Total Quality Management* 12 (5) 575-588

McAdam, R. and Bailie, B. (2002) 'Business performance measures and alignment impact on strategy: the role of business performance models' *International Journal of Operations and Production Management* 22 (9) 972-996

Mehra, S. and Ranganathan, S. (2008) 'Implementing total quality management with a focus on enhancing customer satisfaction' *International Journal of Quality and Reliability Management* 25 (9) 913-927

Meredith, J. (1998) 'Building operations management theory through case and field research' *Journal of Operations Management* 16 (4) 441-454

Miguel, P.A.C. (2003) 'The state-of-the-art of the Brazilian QFD applications at the top 500 companies' *International Journal of Quality and Reliability Management* 20 (1) 74-89

Millar, I. (1999) 'Performance improvement. Part 1. Forget the acronyms' *Industrial Management and Data Systems* 99 (4)

Miller, D. (2002) 'Making Changes' *Quality World* April 20-22

Neely, A., Gregory, M. and Platts, K. (1995) 'Performance measurement system design' *International Journal of Operations and Production Management* 15 (4) 80-116

Neely, A., Mills, J., Platts, K., Richards, H., Gregory, M., Bourne, M. and Kennerley, M. (2000) 'Performance measurement system design: developing and testing a process-based approach' *International Journal of Operations and Production Management* 20 (10) 1119-1145

Patti, A.L., Hartman, S.J. and Fok, L.Y. (2001) 'Investigating organisational quality management maturity: an instrument validation study' *International Journal of Quality and Reliability Management* 18 (9) 882-899

Prabhu, V., Yarrow, D. and Gordon-Hart, G. (2000) 'Best practice and performance within Northeast manufacturing' *Total Quality Management* 11 (1) 113-122

Quazi, H.A., Jemangin, J., Kit, L.W. and Lee, C. (1998) 'Critical factors in quality management and guidelines for self-assessment: The case of Singapore' *Total Quality Management* 9 (1) 25-55

Schaffer, R.H. and Thomson, H.A. (1992) 'Successful change programs begin with results' *Harvard Business Review* January-February 80-89

Sharma, M. and Kodali, R. (2008) 'Development of a framework for manufacturing excellence' *Measuring Business Excellence* 12 (4) 50-66

Simon, A., Sohal, A. and Brown, A. (1996) 'Generative and case study research in quality management Part 1: theoretical considerations' *International Journal of Quality and Reliability Management* 13 (1)

Soltani, E., Gennard, J., van de Meer, R.B. and Williams, T. (2004) 'HR Performance evaluation in the context of TQM: a literature review' *International Journal of Quality and Reliability Management* 21 (4) 377-396

Soltani, E., Lai, P.C. and Gharneh, N.S. (2005) Breaking through barriers to TQM effectiveness: lack of commitment of upper-level management' *Total Quality Management* 16 (8-9) 1009-1021

Sousa, R. and Voss, C.A. (2001) 'Quality management: Universal or context dependent?' *Production and Operations Management* 10 (4) 383-404

Su, Q., Li, Z., Zhang, S.X., Liu, Y.Y. and Dang, J.X. (2008) 'The impacts of quality management practices on business performance: an empirical investigation from China' *International Journal of Quality and Reliability Management* 25 (8) 809-823

Tari, J.J. (2005) 'Components of successful total quality management' *The TQM Magazine* 17 (2) 182-194

Thawatchai, J. and Rao, S.S. (2007) ‘A meta-analysis of quality measures in manufacturing system’ *International Journal of Quality and Reliability Management* 24 (1) 78-102

Thiagarajan, T. and Zairi, M. (1998) ‘An empirical analysis of critical factors of TQM: a proposed tool for self-assessment and benchmarking purposes’ *Benchmarking for Quality Management and Technology* 5 (4) 291-303

Voss, C., Tsikriktsis, N. and Frohlich, M. (2002) ‘Case research in operations management’ *International Journal of Operations and Production Management* 22 (2) 195-219

Wilkinson, A. (1992) ‘The other side of quality: ‘soft’ issue and the human resource dimension’ *Total Quality Management* 3 (3) 323-329

Wilkinson, A., Marchington, M. and Dale, B. (1993) ‘Enhancing the contribution of the human resource function to quality improvement’ *Quality Management Journal* 1 (1) 35-46

Wilkinson, A., Redman, T. and Snape, E. (1995) ‘New patterns of quality management in the United Kingdom’ *Quality Management Journal* Winter 37-51

Witcher, B.J. and Butterworth, R. (1997) ‘Hoshin Kanri: A preliminary overview’ *Total Quality Management* 8 (2&3) 319-323

Witcher, B.J., Chau, V.S. and Harding, P. (2008) ‘Dynamic capabilities: top executive audits and Hoshin Kanri at Nissan South Africa’ *International Journal of Quality and Reliability Management* 28 (6) 540-561

Appendix

Appendix A1: Summary of Selected Papers

SARAPH, BENSON and SCHROEDER (1989) AN INSTRUMENT FOR MEASURING THE CRITICAL FACTORS OF QUALITY MANAGEMENT.

Paper is a thorough literature review of quality practices to develop 8 factors of quality management. Describes a tool for measuring the existence and strength of these factors and a way of relating the set of factors to quality performance. The instrument uses subjective measures based on manager's perception.

FLYNN, SCHROEDER and SAKAKIBARA (1994) A FRAMEWORK FOR QUALITY MANAGEMENT RESEARCH AND AN ASSOCIATED MEASUREMENT INSTRUMENT.

Paper uses empirical and practitioner literature to develop 7 dimensions of quality management. These are tested for reliability and validity as Saraph *et al*. (1989). Describes a tool for measuring the existence of the factors and shows they can be related to 2 quality performance measures (one objective and one subjective). This instrument uses multiple surveys of individuals at different levels in the organization to test the strength of the quality dimensions.

FLYNN, SCHROEDER and SAKAKIBA (1995) DETERMINANTS OF QUALITY PERFORMANCE IN HIGH AND LOW QUALITY PLANS.

Identifies 6 dimensions of quality management, supported by 12 scales and 64 quality practices (refined to 42 after tests). Survey established level/strength of use of the practices, then analyzed data in groups of high, intermediate and low performance companies, according to 1 performance measure. Tried to establish whether the level of usage was a predictor of performance.

POWELL (1995), TOTAL QUALITY MANAGEMENT AS COMPETETIVE ADVANCE: A REVIEW AND EMPIRICAL STUDY

Uses a small sample survey of manufacturing and service firms to determine whether TQM affects firm performance and leads to competitive advantage. The research tested/controlled for industry TQM/non TQM firms, firm size and concluded that the tacit factors- open culture, executive commitment and employee involvement had the greatest affect on performance. Survey used 12 TQM factors and 13 subjective measures of performance.

AHIRE, GOLHAR AND WALLER (1996), DEVELOPMENT AND VALIDATION OF TQM IMPLEMENTATION CONSTRUCTS.

Empirically develops 12 constructs of integrated TQM strategies and framework to test their effects on a firms product quality. The constructs comprise 10 quality improvement strategies and 2 product quality measures. Survey completed by plant managers in US automotive manufacturing industry.

MADU, KUEI AND JACOB (1996) AN EMPIRICAL ASSESMENT OF THE QUALITY DIMENSIONS ON ORGANISATIONAL PERFORMANCE.

Listed middle managers perceptions to assess whether 3 quality dimensions were related to organizational performance. The survey and results were empirically validated and also analysed according to whether it was manufacturing/service, firm age, firm size, and whether had/did not have quality department.

ADAM, CORBETT, FLORES, HARRISON, LEE, RHO, RIBERA, SAMSON AND WESTBROOK, (1997) AN INTERNATIONAL STUDY OF QUALITY IMPROVEMENT APPROACH AND FIRM PERFORMANCE

Based on the work of Saraph *et al.* (1989), Benson *et al.* (1991) and Adam *et al.* (1994), an international study was conducted to determine whether the quality improvement approach of one nation/region works best elsewhere. Model contained 9 factors, supported by 39 quality improvement items to establish relationship to quality performance, financial performance and other performance indicators.

CHOI AND EBOCH (1998), THE TQM PARADOX: RELATIONS AMONG TQM PRACTICES, PLANT PERFORMANCE, AND CUSTOMER SATISFACTION

The strength of the relationship between TQM practices, plant performance and customer satisfaction is empirically tested following a survey of manufacturing firms. TQM practices grouped according to Baldridge criteria but not justified at an activity level. Found strong relationship between both TQM, customer satisfaction and plant performance (significantly correlated).

ANDERSON AND SOHAL (1999) A STUDY OF THE RELATIONSHIP BETWEEN QUALITY MANAGEMENT PRACTICES AND PERFORMANCE IN SMALL BUSINESSES

Used the Australian Quality Award framework to identify six practices and measure the impact on product and business performance measures in SME's. Found significant relationships between practices and performance, and the practices should be selected depending on the measure of interest although the results largely differed from existing published research.

DOW, SAMSON AND FORD (1999), EXPLODING THE MYTH: DO ALL QUALITY MANAGEMENT PRACTICES CONTRIBUTE TO SUPERIOR QUALITY PERFORMANCE?

Used a large scale survey to identify the 9 main dimensions of quality management practices and how these practices interact to produce superior quality outcomes (product quality focus, with 4 quality outcome measures). Used Structural Equation Modelling to investigate nature of relationship between practices and to performance.

HO, DUFFY AND SHIH (1999), AN EMPIRICAL ANALYSIS OF EFFECTIVE TQM IMPLEMENTATION IN THE HONG KONG ELECTRONICS MANUFACTURING INDUSTRY

Based on Saraph *et al*. (1989) and Flynn *et al*. (1995) divided the quality practices into two categories: quality management infrastructure and core quality management practices. Infrastructure practices supported core practices which affect quality performance then customer satisfaction in a model tested by survey in Hong Kong electronics industry, and found mixed relationships between practices and performance.

JOSEPH, RAJENDRAN AND KAMALANABHAN (1999), AN INSTRUMENT FOR MEASURING TOTAL QUALITY MANAGEMENT IMPLEMENTATION IN MANUFACTURING BASED BUSINESS UNITS IN INDIA.

Takes model developed by Saraph *et al.* (1989) and following pretest and factor analysis ends up with 10 critical factors, comprising 106 operating system elements, of which about half are new. Content of new items not fully explained/justified. Empirical analysis briefer than Saraph's. (Did not analyze Saraph's research methodology for weaknesses, adoption not justified.)

RAO, SOLIS AND RAGHUNATHAN (1999) A FRAMEWORK FOR INTERNATIONAL QUALITY MANAGEMENT RESEARCH: DEVELOPMENT AND VALIDATION OF A MEASUREMENT INSTRUMENT

Identified 13 quality practices (initially derived from MBNQA but extended based on literature review) and surveyed many countries to obtain international perspective. Compared model to Saraph *et al.* 1989, Flynn *et al.* 1994 and Ahire *et al.* 1996 models and was more comprehensive than Saraph's and Flynn's and equivalent to Ahire's.

SAMSON AND TERZOVSKI (1999), THE RELATIONSHIP BETWEEN TOTAL QUALITY MANAGEMENT PRACTICES AND OPERATIONAL PERFORMANCE

Uses a large scale survey (Australia and New Zealand) and adopts the 6 criteria from the MBNQA as the TQM mode elements. Uses elements as a whole represent TQM and determine impact on organizational performance.

CURKOVIC VICKERY AND DROGE (2000), QUALITY RELATED ACTION PROGRAMS, THEIR IMPACT ON QUALITY PERFORMANCE AND FIRM PERFORMANCE

Survey of US 1st tier automotive industry suppliers, examining 10 quality programs and relationship of these to quality performance (measures based on Garvin 1987), and firm performance financial measures all assessed objectively. Identifies some programs have greater influence than other on the different measures, and that an indirect link from program to quality performance to financial performance exists in some instances.

Appendix A2: Letter to Case Study Company

Company name
Address

Dear ……..

Many companies have acknowledged that achieving quality leads to increased customer satisfaction and market share. All companies achieve quality differently, some through formal programmes such as Six Sigma or Lean Manufacturing, whilst other companies have a more informal approach to quality improvement. Research at Coventry University is currently examining which quality practices are actually being performed. The purpose of this research is to determine links between actual quality practices and quality practice theory.

It is well known that COMPANY NAME has a highly regarded quality reputation and as such I would very much appreciate it if you could participate in this research. Would it be possible, please, for you to spare the time for a short interview to discuss the actual quality practices that your company has deployed to achieve its' quality goals. All information received will be treated confidentially and a short report on my research findings will be available should you require it.

I am able to come and visit you at any convenient time during September. I will call you in the next few days for an exploratory discussion.

Yours sincerely,

Gillian Cooke BEng (Hons) CEng MIEE Wh Sch
Senior Lecturer
Engineering Manufacture and Management Group
School of Engineering

Appendix A3: Interview Guide

Structured Questions

General Company Information

No. Employees (total) On surveyed site

Turnover

Age of Company Age of site

Is company making a profit or loss? Is site in profit or loss

Is the profit/loss increasing or decreasing?

Production volume (finished products) 2001?

Product range (briefly described)

Interviewee Profile

Title

No. years at company

No. years in current position

No. direct reportees

No. staff responsible for

Job description/responsibilities (in brief)

Terminology

1. When you discuss quality practices in the company what generic names are they called? For example….

For the purpose of this interview we will use the terminology:

Quality

1. Please describe the first quality program that was implemented, mentioning when this was, it's purpose and the quality practices deployed.

2. Describe the aims and objectives of the current quality program.

3. If these are formally documented, how are employees made aware? (can I have a copy please)

4. When was the current quality program initiated and how?

5. Please describe how the first quality program has evolved into the existing program.

6. What are the key strategic quality practices of the current quality program?

7. Describe how the strategic quality practices are translated into actual quality activities.

8. What specific quality activities are currently being performed on a regular basis (weekly)

9. Which quality activities comprised the first quality program?

10. How have the original quality activities evolved into the current activities.

11. How do you evaluate the effectiveness of the current quality program? That is, how do you know it fulfils its aims and objectives?

12. How do you know that the company is doing the right quality activities to achieve the desired strategic objectives, that is, that they are aligned?

Appendix A4: Industrial Case Study Report

1.0 Introduction

Research at Coventry University has been examining the relationship of quality practices to performance. It has discovered that much of the research in this area focuses on strategic level quality practices e.g. employee empowerment, supplier development, process improvement, management support, data gathering, etc. The driver for doing this research is to help quality practitioners understand fully the contribution these practices make to a quality programme (e.g. Six Sigma and TQM) and quality performance.

However, our analysis of this quality practice performance relationship research has discovered that:

- There is no agreed overall 'set' of strategic quality practices that form the core of a quality programme. Usually companies select their own set of practices to suit their own specific criteria.
- There is currently no consensus as to which quality practices affect performance. Also, to compound the problem further the performance measures used vary considerably.
- The strategic quality practices are focused upon generic themes rather than specific quality activities, such as quality tools and techniques (e.g. SPC, QFD etc)
- Models are being developed that link together these different quality practices. However, this work considers only the strategic quality practices and analyses the quality practice terminology and their relationships from a theoretical perspective.
- Models are being developed that link together quality activities (e.g. tools and techniques such as QFD, FMEA and SPC). There are a number of models available. However, none of them have aligned the activities to the strategic quality practices.

Our aims are to focus on the actual quality activities performed as part of a quality programme and relate these to strategic quality practices.

1.1 The Study

This report summarises the findings from case studies conducted during autumn 2002. Four companies were visited from 3 industrial sectors: two automotive (non-competitive), an aerospace and a white goods company. Differing industrial sectors were selected so the findings could be generalised across industry types. At three of the companies two visits were permitted, and individuals with differing levels of responsibility for quality were interviewed in order to obtain information from different perspectives. This data was used to produce a

report about each company specifically focussing on the following questions in order to identify common conclusions:

- What are the aims and objectives of the quality programme? How is the programme operationalised?
- Which strategic quality practices are evident at the companies?
- What are the quality activities of typical quality programmes?
- Is there a link between the quality programme, strategic quality practices and the actual quality activities deployed? Can the link between quality practices and quality activities be mapped to indicate alignment?

2.0 Case Study Findings

2.1 The Quality Programmes

The main objective at Company A is customer satisfaction. Customer feedback concerning satisfaction levels is used to generate performance measures, which in turn drive the quality programme and quality activities. Performance management and measurement are integral elements of the quality programme. The quality programme is designed to include activities other than quality specific ones and to reflect the way of working for all employees, therefore it could also be described as a business operating system. In addition to customer satisfaction, other objectives and targets are set but there is not a direct link between these and the quality programme.

The investigation at Company B revealed that a formal quality programme or system for the deployment of quality activities/improvement actions did not exist. It appeared that quality was primarily the responsibility of the quality department. The objectives (of the quality activities) were described as ‘getting control, customer satisfaction and cost reduction’ but could not be quantified. A formal system for cascading the company’s business objectives into departmental objectives exists but it does not refer to the aforementioned quality-related objectives.

Company C aims to satisfy the organisation's stakeholders. There are a number of programmes that integrate to form a cohesive system for achieving quality objectives. Objectives and performance measure targets articulate stakeholders’ requirements. Firstly, the targets are documented in action plans and activities (including some quality tools and techniques) are deployed to fulfil the targets. Secondly, each manufacturing area has a quality system that specifies the day-to-day activities to ensure performance monitoring and improvement. Finally there is the Six Sigma programme which consists of projects to improve business performance, determined based upon the company’s objectives and performance targets and therefore are not necessarily quality specific.

Company D has a formal company-wide quality programme known as Six Sigma. The aim of the programme is to enable the company to achieve various strategy and performance objectives. Projects are established to address specific performance targets, of which some are quality orientated.

2.2 Strategic Quality Practices

None of the companies visited used the academically recognised phrase 'quality practice' or directly mentioned the quality practices by name. The three data sources (interview transcripts, documentation and questionnaires) were analysed to determine the extent to which the strategic quality practices appeared to exist at each of the four companies. This analysis consisted of assessing the data to determine whether the quality practices 'subconsciously' existed, then using the frequency of occurrence when compared against each other to determine the extent of existence. These findings are shown in table 1.0.

Company Classifying Codes	A	B	C	D
Top management support	H	H	M	H
Strategic quality planning	H	H	H	L
Quality information availability	H	M	H	H
Quality information usage	H	M	NK	NK
Employee training	M	L	H	NK
Employee involvement	L	L	NK	NK
Product/process design	NK	L	M	L
Supplier quality	NK	L	L	L
Customer orientation	H	NK	M	M

Extent to which quality practices exist: H = High, M = Moderate, L = Low, NK = Not Known

Table 1.0: Extent to which quality practices exist based upon all evidence sources

The code NK (Not Known) indicates that all data sources presented different results concerning the existence of a practice and therefore firm conclusions could not be reached. Further research about these practices is required in order to establish the extent of their existence.

The table can only be used for within company comparisons, as it reflects the presence of the practices relative to each other in a company. Company B has the most practices that exist to a low extent, and this supports the earlier finding concerning the apparent lack of formal quality programme. Company D has the most NK, and this is probably due to only one visit, resulting in less data and hence less possibility of agreement between data sources.

Companies should not be compared on a practice by practice basis because a high existence at one company may not be characterised in the same way at another company. That is, for example, top management support exists to a high extent at companies A, B and C, but all three companies operationalise this practice differently. Similarly, a company that has a practice existing to a moderate extent may do the same activities as one where the practice exists to a high extent.

2.3 Quality Activities

The table (2.0) shows the tools and techniques that were specifically identified during each visit.

Tools and Techniques				
Present at Company:	**A**	**B**	**C**	**D**
Quality Function Deployment (QFD)	X	X		X
Failure Modes and Effects Analysis	X			X
Taguchi Techniques (DoE)	X			X
Statistical Process Control (SPC)	X	X	X	X
8D problem solving	X	X		
Six Sigma	X	X	X	
Quality System/ISO 9000	X	X		
Design for Assembly	X			
Poka Yoke	X			
Product Audit	X			
ISO 14000	X			
(Team) Problem solving	X	X		
Advanced Product Quality Planning	X			
Simultaneous Engineering Teams	X			
Pareto chart		X		
Total Productive Maintenance (OEE)		X		
Kaizens/Opportunities for improvement		X	X	
Fishbone Diagrams		X	X	X
Root cause analysis			X	
5 Whys			X	
Advanced Statistical Tools/Techniques			X	X
Customer/supplier relationships			X	
Employee opinion surveys			X	
Team building				X
Process Mapping				X
Facilitation skills				X
In and out the frame				X
Forcefield analysis				X
Elevator speeches				X

Table 2.0: List of Tools and Techniques identified during Company visits.

The quality activities at Company A are integrated into the quality programme in such a way that they have become part of the way the employees work. Fourteen different quality tools and techniques were specifically identified. In contrast, at Company B, although ten quality tools and techniques were identified these tend to be used to address customer issues on an ad-hoc responsive basis. Quality activities are the main components of the quality programmes at Company C and nine tools and techniques were specifically identified. The quality activities are used within the Six Sigma programme, the action plans and the manufacturing quality system. There is a strong focus on quality activities at Company D and twelve tools and techniques were specifically identified. Data orientated tools and techniques are used directly within six sigma projects and employee focused quality activities are used to support and facilitate change.

Only SPC was mentioned at all four companies whilst Fishbone diagrams, QFD and 8D problem solving were mentioned at three companies. Seven activities were identified by two companies and eighteen were mentioned just once, suggesting that companies use a variety of different quality activities.

2.4 The Link between the quality programme, strategic quality practices and quality activities.

In order to examine the links between the quality programme, strategic quality practices and quality activities network diagrams were constructed to map the relationships. These are shown in Figures 3.0, 4.0, 5.0 and 6.0 for companies, A, B, C and D respectively.

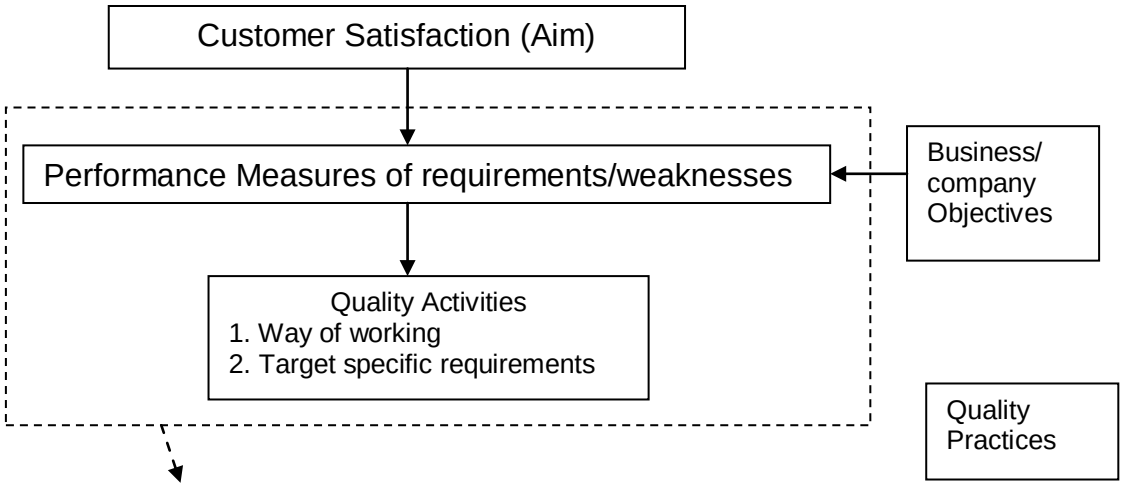


Figure 3.0: Company A network diagram

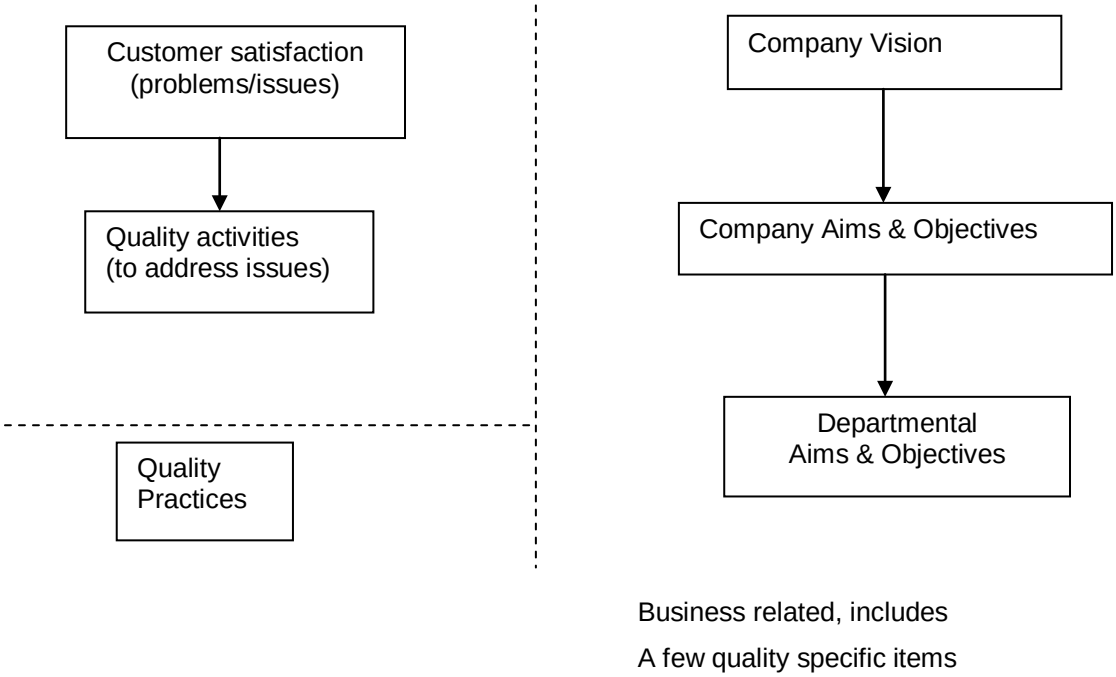


Figure 4.0: Company B network diagram

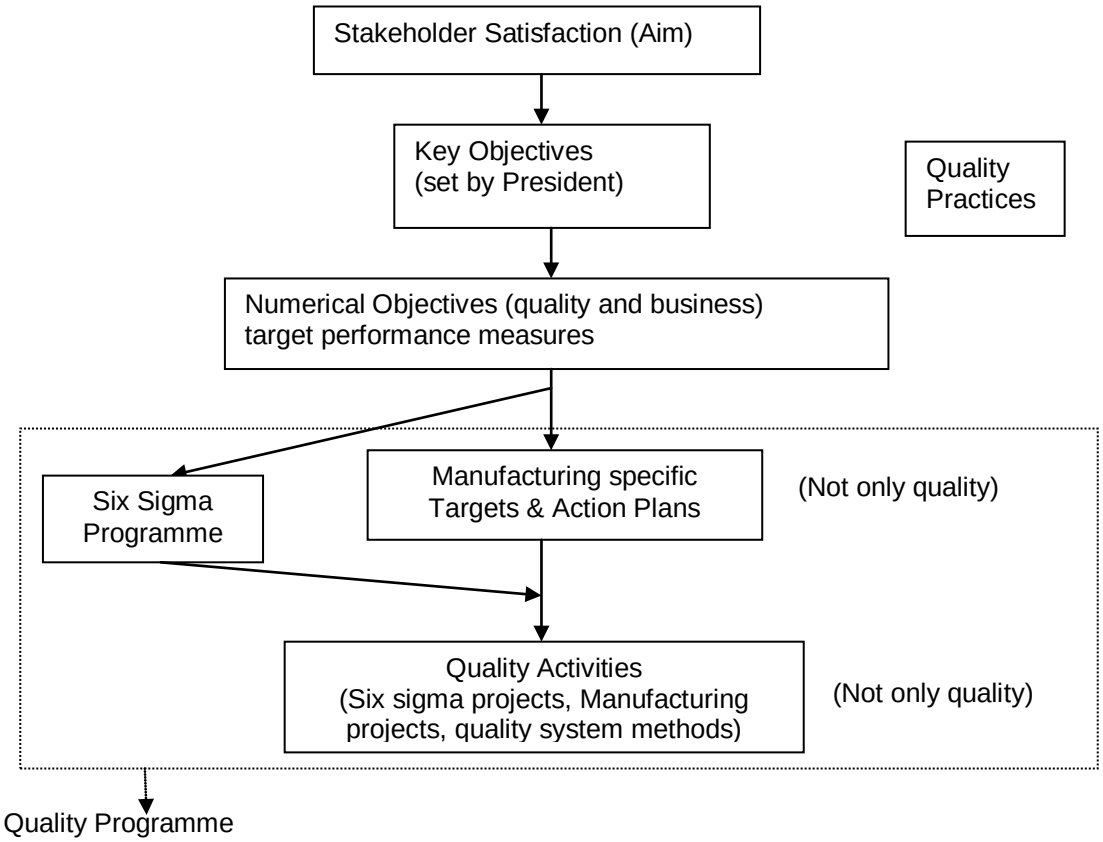


Figure 5.0: Company C network diagram

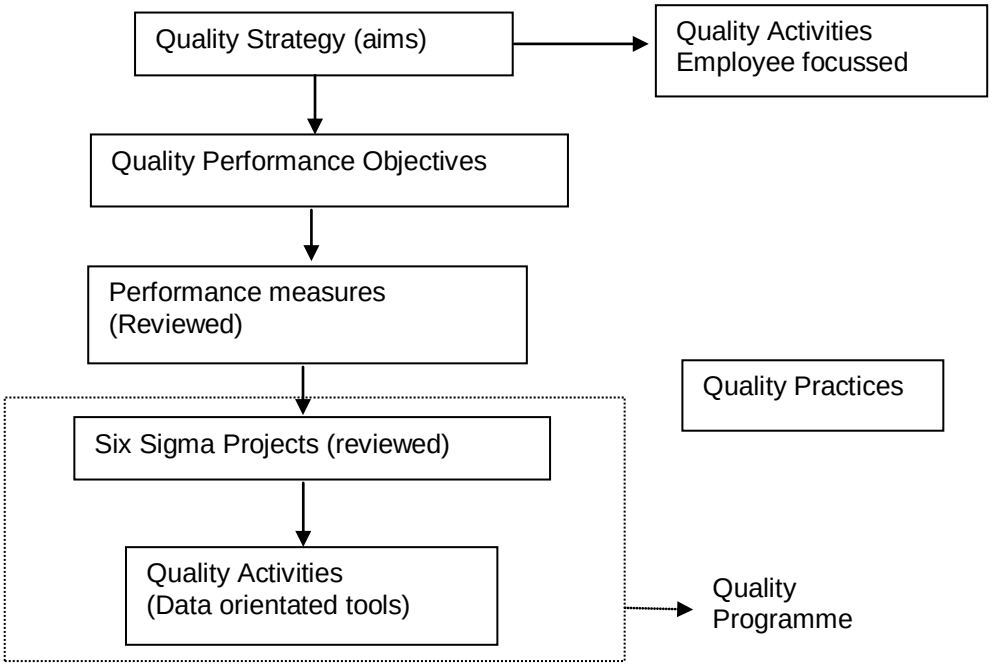


Figure 6.0: Company D network diagram

It has not been possible to integrate Quality Practices into any of the diagrams because the companies did not use the phrase and did not directly recognise or use the strategic quality practice terminology. The quality programme could be identified on the network diagram for Company's A, C and D, but not B because a formal programme was not mentioned during the visits. All the diagrams show downward links from the company's aims to quality activities. However, none of the companies performed upward evaluations/checks to confirm that the activities deployed were in fact achieving the aims. Although Company D felt this was achieved by reviewing the performance measures. During the visits, Company A, B and C expressed an interest in exploring the links and relationships further in order to establish which quality activities produced the best results.

3.0 Conclusions and Further Work

The main conclusions from the case studies can be summarised as:

- The aims of the quality programmes tend to be 'satisfaction' orientated, in particular customer satisfaction is a key driver.
- The objectives of the quality programmes are expressed numerically, and through performance management and measurement systems provide quantifiable targets for the activities of the quality programme. Performance measurement is seen as critical to success and the main driver of activities within companies. This is significantly different to the academic quality-orientated research which views quality performance results as outputs of the activities rather than drivers.

- The term quality programme has become a generic label and provides companies with a framework to enable focussed application of quality activities. This investigation found that the component parts of a quality programme differs between companies along with the programme name, key activities and management approach. But the network diagrams revealed that certain key phases are necessary: Articulate aims, quantify numerical performance objectives, allocate specific activities/project for each objective.
- Formal programmes are business wide and include more than quality activities.
- The phrase quality practice and the strategic quality practice names used by academia (particularly on questionnaires) were not used at any of the case study companies. How effectively the questionnaire articulates the quality practices needs further investigation because when the results were compared to those obtained from interview and documentation sources, anomalies were found at one company. In some instances the questionnaire items did not sufficiently articulate a practice even when a company seemed to be highly focused on a particular practice.
- Different quality practices exist to different extents in the different companies. Although within company comparisons of the relative strengths of the practices against each other is recommended, it is not possible to compare between companies.
- Quality activities (tools and techniques) are the main component of the quality programme. The companies identified a largely different and yet limited number of tools and techniques, which suggests a high variability in terms of how the companies address their performance targets and hence aims.
- Information was not available concerning the actual selection and deployment of quality activities. It was only possible to ascertain how the quality activities integrated into the quality programme.
- The existence of a formal programme enables a network diagram to map the link from the aims to quality activities. None of the companies perform any upward evaluation of the effectiveness of these activities in achieving the required performance and neither are any comparisons of the usefulness of the activities made.

- These conclusions have resulted in the identification of a number of areas for further work. These include:
- Developing and testing a generic framework that links aims and objectives to quality activities. This should also include a common language so that academia and industry can communicate more effectively.
- Test the findings concerning the phrase ‘quality practice’, the strategic quality practice names and questionnaire items across a larger sample of companies and industries.
- Investigating the methods of selection and deployment of quality activities (the tools and techniques). Then if possible, develop a tool to enable companies to establish the benefits achieved using certain tools, and therefore promote comparisons and ultimately more effective tool selection/deployment.

Appendix A5: EI Case Study Report

1.0 Introduction

This Case Study report complements Chapter 7, in which the results of two case study investigations have been summarised. Therefore this report describes each of the case studies and the associated data collection, collation and analysis process which were conducted. These have been conducted in accordance with the research methodology documented in Chapter 3. Both studies have investigated the activities performed by operational manufacturing personnel in order to evaluate the quality activities performed on a day-to-day basis. Study One formed the preliminary investigations and analysis, which led to Study Two for refinement of the early findings.

2.0 Study One

2.1 Overview

The purpose of study one is to focus on three of the research questions identified in Chapter 3, Research Methodology (section 3.2.2)

1. What is a suitable method for collecting data concerning the use of quality activities in an individual's day-to-day role?
2. What are the quality activities that an individual engages in? Can these be separated from their other tasks, that is, can they be individually identified and analysed?
3. Can a set of definitions and framework be created which will facilitate consistent analysis of the activities?

Therefore study one is particularly concerned with the research methods and preliminary analysis and associated initial findings.

A regional aerospace manufacturing company, which had recently won the Midlands EFQM Award, was selected for Study One. Full justification and details can be found in Chapter 3, section 3.6.

2.2 Data Collection

Only data obtained through Participant Observation was available from the case study organisation obtained by spending two full days on site: firstly with a Cell Member (production worker) and secondly with a Team Leader (production worker with supervisory and organisational responsibilities). Throughout each day, every activity was recorded along with the time spent on it and this was subsequently word-processed to facilitate analysis (as

shown in Table 1.0). Full textual data for the Cell Member and Team Leader is contained in the case study database.

10.03	Start crimp operation (4 mins)
10.08	Saw extra hose sleeve
10.09	Put jig back, tidy work area, move to test rig
10.11	Set up test rig, adapters stored close by.
10.14	Pressure test. Air blast parts after test.

Table 1.0 Example of Cell Member Activities

2.3 Data Analysis

Data analysis has followed a content-led analytic approach, using the categories Direct and Indirect (based on the Literature Review, Chapter 2) to start the process. Every task performed has been evaluated and classified according to these categories as part of the within case analysis. After each analysis and categorisation process, then the cross case analysis was conducted: the results were reflected upon and definitions updated to reflect themes emerging for the research (as grounded theory suggests). Then the analysis and categorisation process was conducted again, therefore leading to the iterative process. Over the course of the iterations definitions (for Direct and Indirect) and method (for classification) has emerged from the research. The detailed analysis results supporting the iterations are contained in the case study database.

2.3.1 Analysis Iteration 1

The first analysis process was performed using the traditional simple definitions of a direct activity (value adding, i.e. production) and indirect activity (non value adding, i.e. inspection, set-up etc) as can be seen in Table 2.0.

Time	ACTIVITY	Direct	Indirect	Comments
10.03	Start crimp operation (4 mins)	4 min		
10.08	Saw extra hose sleeve	1 min		
10.09	Put jig back, tidy work area, move to test rig		2 min	
10.11	Set up test rig, adapters stored close by.		3 min	
10.14	Pressure test. Air blast parts after test.	6 min		

Table 2.0 Example of Direct and Indirect Classification – Iteration 1

Reflection on this iteration process and the results of the analysis identified a number of issues concerning both the collection method and the identification of the activities. Firstly, direct activities were a very small portion of the day-to-day tasks and consequently the indirect activities were very complicated as the category included the remaining tasks. Therefore further analysis of the indirect activities was attempted by classifying them as either production, quality or other emerging themes, depending on their nature (Table 3.0).

Time	ACTIVITY	Direct	Indirect	Comments
10.09	Put jig back, tidy work area, move to test rig		2 min	5S – quality
10.11	Set up test rig, adapters stored close by.		3 min	Production or inspection (quality)

Table 3.0 Example of extra categorisation within the Indirect Category

However, whilst the initial classification as direct and indirect was straight forward this detailed reclassification of the indirect activities was extremely complicated and hence time consuming. The focus became the classification category rather than the findings/results and what this meant for quality activities. Additionally some of these activities could be considered as positive in the manner that they contributed to quality improvement or preventing poor quality and whilst others negative in as much as they were a consequence of something having gone wrong. This attempted next step at iteration was aborted as it was failing against the criteria specified in question 2 and question 3 (refer to 2.1). This task analysis is a tool to enable future quality performance improvement and therefore must be quick, easy and straightforward to do.

2.3.2 Analysis Iteration 2

Given the issues raised in the first iteration and subsequent aborted process, for the second iterative analysis, expanded definitions which overcome these weaknesses were sought. The second analysis iteration was based on the definitions of Goodyer (1998): a direct activity is direct value adding and the major tasks needed to complete the job and have a direct effect on quality; indirect activities include supervision, training, continuous improvement activities etc and have an indirect influence on quality levels.

A review of the classification process found that compared to the first method, classification based on these definitions was significantly quicker and easier to do. But since Goodyer (1998) had not analysed jobs in the manner being attempted here, other issues were identified. For example, interruptions to the Team Leader by the cell members asking for instructions were classed as indirect as they were in fact supervision related. But these activities were part of the Team Leaders' job function and some did directly contribute to product quality (for example by providing guidance about how to do a job). Failure to give adequate instructions could have a direct negative effect on quality. In another case, the workshop practice, and part of an individuals' job, is to tidy between operations and therefore a direct activity. However, this could also be considered an indirect activity as it is part of the 5S's quality technique and it does contribute to quality improvement. In addition, at other companies (for example, not best practice organisations) it is likely that tidying between operations is not standard practice. The indirect activity category also included toilet and refreshment breaks, along with 'passing the time of day' conversations. These are part of a day at work but do not fall into either category. Monitoring and recording this type of activity

and the associated time could prove to be a contentious issue, particularly in less confident and open individuals or organisations.

Therefore, the definitions for both direct activity and indirect activity were modified to take account of these emerging issues. In addition a new category (and definition) has been created to absorb personal activities unrelated to the job.

2.3.3 Analysis Iteration 3

Again the raw data was analysed, this time using the revised definitions of direct and indirect activity and personal (Figure 1.0).

Direct Activity: Are those tasks considered inherent and comprise of the main job function (often detailed in the job description). Typically direct activities are value adding or directly contribute to the value adding tasks, for example, set-up, production, and inspection. Therefore direct activities are intrinsic to the job function, offer opportunity for improvement in the way a task is done and directly contribute to quality and hence improved performance.

Indirect Activity: Are those tasks which do not directly contribute to value adding activities and are typically extrinsic to the normal job function. Indirect activities may include training, continuous improvement activities, helping/supervising peers.
Normally indirect activities contribute to quality performance by enabling improvement in the direct activities, and tend not to directly affect quality in the same way as direct activities.

Personal: This includes all activities that are essential but do not contribute to the job function or company business in anyway. It includes refreshment breaks, toilet breaks etc, outside of allocated times (i.e. lunch time).

Figure 1.0 Definitions: Direct and Indirect Time (Cooke and Goodyer 2000)

An example of the revised classification is shown (Table 4.0) and note that the grey box is the previous classification for the task.

The classification process on this third formal iteration was a lot simpler and it was quicker to allocate the tasks probably because the definitions had emerged from the data and iterative analysis process.

Time	ACTIVITY	Direct	Indirect	Direct	Indirect	Comments
10.45	Start moulding. Insert hose with silicon on end into moulding m/c. 2.5 min cycle time. Trim off excess while another hose in moulding m/c.	10 min		10 min		
10.55	Tea round		5 min		5 min	Personal Time
11.00	Continue with moulding. Stamp up route card during cycle.	30 min		30 min		
11.30	Finish moulding op. Tidy area.		1 min	1 min		

Table 4.0 Example of Iterations 3

Using the definitions as guidance, a framework (Figure 2.0) has been created to facilitate consistent task analysis and document the procedure to follow so that employees' activities can be categorised. The definitions and framework together form an Activity Classification System (ACS).

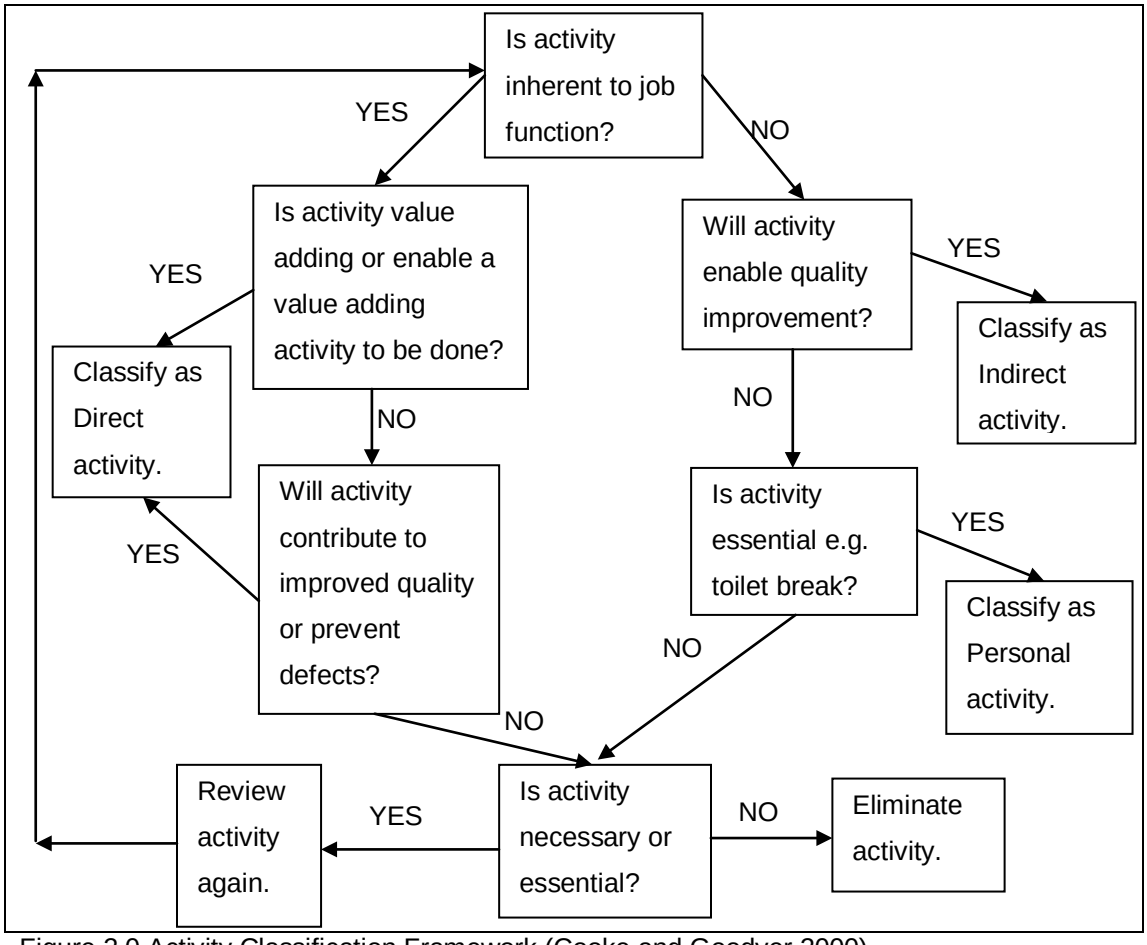


Figure 2.0 Activity Classification Framework (Cooke and Goodyer 2000)

2.4 Study One Discussion and Conclusions

Study One was designed to investigated three questions, which will now be addressed.

1. *What is a suitable method for collecting data concerning the use of quality activities in an individual's day-to-day role?*

Participant observation and recording each activity has provided rich contextual data about individuals' activities. This data is reliable although time consuming to collect and collate.

2. *What are the quality activities that an individual engages in? Can these be separated from their other tasks, that is, can they be individually identified and analysed?*

Examining two individuals with different roles has provided a valuable insight into the variety of quality activities that are performed. But this information is only a snap shot and due to researcher lack of familiarity with the environment the data may contain anomalies. An extended time frame and different roles may provide greater variety of information. Data recording was difficult when activities' durations were shorter than the time taken to record them and also when interruptions to the work flow occurred, for example when the Team Leader was asked questions. The roles in a cellular manufacturing environment have provided a variety of observed quality activities.

3. *Can a set of definitions and framework be created which will facilitate consistent analysis of the activities?*

The detailed description of precise activities has enabled them to be analysed in detail and facilitated the iterative analysis process which in turn has led to the generation of definitions and a framework. These definitions are suitable for the data gathered in study one but require further testing. Also, the new category concerning personal time will need further consideration as individuals may find this contentious and this would need addressing prior to starting participant observation at another organisation.

It can be concluded that Study One has enabled these questions to be answered and has provided a basis on which to continue with the exploratory research.

3.0 Study Two

3.1 Overview

This case study is an extension of Study One and has been conducted in order to test and develop the activity classification system. This study has been based on the tentative hypothesis and refined questions (as specified in Chapter 7, section 7.2.5) which have emerged from the findings of the first investigation. Study Two is a longitudinal in depth case study investigation which was conducted at a local, medium sized aerospace company. Chapter 3, Research Methodology justifies the company selection and research approach.

3.2 Data Collection

This study was conducted over a three month period, where the researcher visited one product-based cell (called module) at least one day per week. Participant observation was the main method for obtaining precise information about individuals' activities. The data recording and collection method replicated the method followed in Study One. The researcher attended and observed departmental (module) meetings, met employees from beyond the module (for example Quality Manager) and had access to documentation (such as quality manuals, work instructions, training documents) which could be read at leisure and appropriate notes made. A strict confidentiality agreement had been signed.

3.2.1 Participant Observation

Seven cell members were specifically selected for intensive observation purposes as between them they covered the range of roles that existed in the cell. It was not possible to spend time with Operators since they worked in a dangerous controlled area subject to strict Health and Safety regulations. Job titles and a summary of the roles and responsibilities of the individuals observed can be found in Table 5.0.

Module Member	**Summary of Roles and Responsibilities**
Module Manager (MM)	Weekly and monthly running of module and long term planning.
Manufacturing Systems Engineer (MSE)	Manufacturing Engineering support for facilities and processes. Ensures equipment is maintained, repaired and improved, processes documented in Work Instructions. Involved in module improvements.
Senior Laboratory Engineer (SLE)	Product quality checks from raw material to finished product. Developing and maintaining department Work Instructions and material specifications.
Production Controller (PC)	Co-ordinate materials and work flow to support production, including raising purchase orders, order expedition and stock control.
Team Leader (A) (TLA)	Organising day-to-day production and people and contributing to production. Ensuring H&S compliance. Conducting process optimisation trials
Team Leader (B) (TLB)	Organising day-to-day production and people and contributing to production. Ensuring H&S compliance.
Senior Operator (SO)	Day-to-day production activities and organisational responsibilities as required by Team Leader and Module Manager.

Table 5.0 Roles and Responsibilities

A whole shift was spent observing each person and the data was recorded which identified the time of the event and a description of the activity (example shown in Table 6.0) and full details can be found in the case study database for each cell member.

Time	Activity Description
6.46	Collected pedestrian truck. Loaded can onto work station.
6.55	Inspected can. Checked for damage, removed burrs and cleaned joint to be welded with wire brush.

Table 6.0 Data Collection Example: Senior Operator

This data was then collated, and the duration of each activity was calculated in order to facilitate subsequent calculations concerning the proportion of time spent on types of activities. Company management felt that the Personal Time category would be contentious so all activities within this category were recorded as PT.

3.2.2 Other Data

The other data collected during the visits consists of informal notes taken during meetings or discussions and information from documentation sources, some in the form of notes and others being duplicate copies of the documentation. This information is stored in the Case Study database. It should be noted that the purpose of this data was too contextualise the data from the participant observation and provide corroboration and explanation for this data when it was subsequently analysed.

3.3 Data Analysis

The data analysis again followed an iterative analytic approach, with each stage building on the preceding. Firstly, the within case analysis was conducted by analysing each cell members activities in turn and then a cross case analysis was conducted in order to identify common themes between the cases. This approach was used for the first analysis where activities were classified as Direct, Indirect or Personal. Then followed again for the second analysis where the quality activities were identified. The second analysis followed a hierarchical coding approach. The third analysis (based on a template analysis approach) used existing quality activity definitions (from literature) in order to add another dimension to the findings. During these three stages the researcher made notes of the observations which arose during the categorisation process (found in case study database) in order to facilitate the last analysis stage. The final analysis stage involved synthesising the findings from the first three stages in order to develop the definitions and framework, which comprise the Activity Classification System.

3.3.1 Stage 1

The activity definitions (Figure 1.0) and framework (Figure 2.0) was used to categorise each activity as either direct or indirect and then the proportion of time spent on it was calculated and tabulated (Table 7.0). This within case analysis was performed for every role observed and is detailed in the case study database.

Time	**Activity**	**Direct Time**	**Indirect Time**
13.00	Used digital camera to take photos of batch pot.	8	
13.08	Uploaded photos to PC	13	
13.21	Sent email to technical lead with photos attached.	3	
13.24	Scan WI and aligned margins	18	

Table 7.0 Example data: Manufacturing System Engineer

Following the individual analysis a cross case analysis was conducted to compare the findings of the categorisation (Table 8.0).

	Direct Time	Indirect Time
Module Manager	100%	0
Manufacturing Systems Engineer	100%	0
Senior Laboratory Engineer	100%	0
Production Controller	100%	0
Team Leader (a)	65%	35%
Team Leader (b)	100%	0
Senior Operator	68%	32%

Table 8.0 Direct / Indirect Analysis

Every activity could be classified using the definitions and framework. The table reveals that all activities performed by staff roles (MM, MSE, SLE and PC) have be categorised as direct. This can be attributed to the fact that the staff job descriptions are very broad and include phrases which state they should do whatever is necessary to do the job. In addition the job descriptions state that employees should participate in continuous improvement and support activities to improve the product and process (as shown in case study database). Note that in calculating these percentages the PT category and its associated time was removed.

3.3.2 Stage 2

The purpose of the second stage of the analysis was to determine which of the direct and indirect activities were specifically quality activities based on the general definitions “contribute to improved quality or prevent defects" and “will activity enable quality

improvement" included in the activity classification system framework. These general definitions resulted in the creation of further lower order codes (refer to the Case Study Database) contained within the broad categories of Direct and Indirect. Once the quality activities had been identified the proportion of time spent on them was calculated (Table 9.0).

	Direct Time Quality Activity	Indirect Time Quality Activity
Module Manager	30%	0
Manufacturing Systems Engineer	88%	0
Senior Laboratory Engineer	24%	0
Production Controller	0%	0
Team Leader (a)	19%	35%
Team Leader (b)	12%	0
Senior Operator	8%	22%

Table 9.0 Direct / Indirect Quality Activity Analysis

During the analysis, it was noted that the quality activity definitions are positive and proactive interpretations and therefore do not reflect quality activities associated with rectifying and solving quality problems which are reactive in nature. During the observations a number of reactive (direct) quality activities were noted (Table 10.0).

Person	Time	Activity Description
Senior Laboratory Engineer	8.05	Return faulty cans to supplies for replacement.
Team Leader (a)	13.40	Talked to operator about scrap query.
Team Leader (b)	8.25	Discussion with Module manager and engineer about the planned layout and system changes and the poor communication of the changes to the shift team.
Senior Operator	7.31	Discussion about supplier quality problems (burrs on cans) with senior laboratory engineer.

Table 10.0 Selection of reactive quality activities present in different roles.

Therefore it was decided to refine the definition of quality activities to take account of this new theme that emerged from the data and generate new appropriate codes. Reactive quality activities are defined as those activities necessary to investigate and correct errors/problems that have already occurred. Proactive quality activities are those activities which prevent poor quality happening and are often improvement orientated. All the individuals' quality activities were analysed to determine whether they are reactive or proactive activities and the proportion of time spent on them (Table 11.0).

	Direct Time Quality Activity		Indirect Time Quality Activity	
	Proactive	Reactive	Proactive	Reactive
Module Manager	29%	1%	0	0
Manufacturing Systems Engineer	16%	72%	0	0
Senior Laboratory Engineer	17%	7%	0	0
Production Controller	0	0	0	0
Team Leader (a)	11%	8%	35%	0
Team Leader (b)	0	12%	0	0
Senior Operator	1%	7%	22 %	0

Table 11.0 Proportion of time on Proactive and Reactive Quality Activities

These cross case analysis results show that individuals participate in both reactive and proactive quality activities and for some a considerable proportion of time. Therefore it is considered necessary to review the individuals' quality activities in more detail and examine the precise nature of the proactive and reactive categories in order to have confidence in these definitions:

Module Manager (MM) spent 30% of his direct time on quality activities, mainly proactive in nature. Close examination of these shows a great variety in the types of tasks undertaken, of which a selection are shown (Table 12.0):

Time	Activity	DT	IT
7.15	Updated Consignment stock usage figures on PC to produce KPI's. Calculate p/kilo per month and year-to-date spend. Updated PowerPoint charts in order to display KPI information.	32	
7.47	Checked WI, anomaly found.	1	
7.48	Took WI to Manufacturing Systems Engineer and discussed changes required.	2	
8.17	Two operators came to office to discuss what could be done as they had accidentally filled the wrong size can with powder. Cans are poorly identified.	3	
13.45	Completed requisition for experimental material powder (potential process improvement project)	5	

Table 12.0 MM Direct Time Quality Activities

At 7.15 the MM is evaluating quality performance and producing key performance indicators for the previous month for publication. Although this is a proactive quality activity, it may encourage improvement but it is really about controlling and managing quality. The activities at 7.47 and 7.48 are about maintaining the accuracy of the quality management system by ensuring procedures are up-to-date. These procedures were being corrected in order to prevent internal audit non conformances or work being done incorrectly. At 8.17 the activity

was trying to determine the action required to correct a defect and as such was reactive. Finally the activity at 13.45 is part of a locally led investigation into potential opportunities for process improvement which may become a process improvement project. Currently this activity is a direct time proactive activity focused on improvement. The MM spent the greatest proportion of time on direct quality activities, partly because his role indicates he should do whatever is required but also as he is responsible for the "smooth running of the cell" then actions which are proactive would contribute to this philosophy. All the activities which were undertaken could be considered as integral to his function and part of his day-to-day activities.

Manufacturing System Engineer (MSE) spent the highest proportion of time on quality activities, with 76% of time allocated to reactive direct quality activities. Typical activities include (Table 13.0):

Time	Activity	DT	IT
7.35	… Recorded order no. for ventilation equipment. (This has been purchased by MSE to keep the hydraulics room cool since overheating has caused equipment to fail which results in MA m/c downtime). MSE to cost long term solution to fix overheating problem of hydraulic room. Discussed contamination problem in shop floor area (wheel had failed test due to inclusion). Stronger magnets were to be used at the magnetic separation stage to remove contamination. MSE to source.	17	
7.57	On PC checked progress of order for trackless gate system (for quarantine area due to internal audit non-conformance). Order still not raised.	5	
13.42	Request from senior operator to produce a sign and laminate it. Wrote a requisition for cleaning fluid for ultrasonic tank for the Senior Operator.	4	
14.00	Issued working copies of WI's to shop floor locations and removed contraband 'gauges' from use.	12	

Table 13.0 MSE Direct Time Quality Activities

The activity at 7.35 is representative of the role of MSE, largely focusing on problems caused by machine failure and implementing immediate solutions and then trying to investigate and cost long term solutions. There were many failure orientated activities the MSE engaged in during the day including at 7.57 where the failure was the quality management system. At 13.42 the activity is associated with preventing product quality problems, failure to do it may result in later problems but doing the task does not have a direct outcome, in some respects it is improvement orientated. Whereas the activity at 14.00 is designed to ensure that the operators are following the correct instructions and will directly affect quality performance – firstly in terms of audit non conformance measures and preventing future non-conformances

but also preventing errors in work practices, yet this activity is about ensuring compliance and maintaining control.

Senior Laboratory Engineer (SLE) spent 24% of his time on direct quality activities, the majority of which (17%) could be considered proactive (Table 14.0):

Time	Activity	DT	IT
7.32	Went to shop floor to view defective can with possible 'tear'. Checked remaining cans in the batch. Found some with thin walls and 'crocodile effect' to the surface.	10	
7.42	Returned to office to collect micrometer and conductivity checker. Checked specification for minimum acceptable levels.	2	
7.44	Returned to shop floor and measured two cans to be outside specification limit. Used conductivity meter to check a sample of cans.	7	
7.51	Took 1 can to maintenance dept as it had a lump of swarf stuck to the bottom of the can that needed to be removed. Removal revealed a 'hole. Put can into quarantine area.	3	
7.54	Discussion with Senior Operator concerning the weldability of the cans with the thin walls. Operator examined cans and said they were unacceptable. Moved cans to quarantine area.	3	
8.05	Discussed with Production controller and it was agreed that cans should be returned and that the supplier was to be informed that the 4 faulty cans must be replaced.	2	
9.04	Used computer system to raise a non conformance report (NCR). Printed report.	26	

Table 14.0 SLE Direct Quality Activities

The SLEs' role involves a significant amount of inspection (activities at 7.32 and 7.44) which are categorised as Proactive, as they prevent poor quality items being further processed, although necessary it does not lead to improvement and is really about ensuring compliance and control. These activities have led to reactive quality activities (7.51, 7.54 and 8.05) in order to manage the poor performance of the supplier. The activity at 9.04 is also concerned with the internal management of poor quality and ensuring control of the defects and initiates the action to correct and rectify the problem. Unfortunately none of these activities are improvement orientated.

Production Controller (PC) did not do any quality activities on the day of the observation. Although the job description indicates that the PC should participate in CI and support activities to improve product and process as well as supply chain development. In some organisations, staff job descriptions are vague enough to include almost any activity and in addition can tend to mention quality/continuous improvement in its broadest sense as part of the role. Therefore this should be considered in a review of the Indirect Activity definition.

Team Leader A (TLA) is one of two people with indirect quality activities and TLA had the highest proportion of time spent on these proactive quality activities and also spent time on direct quality activities, examples shown (Table 15.0):

Time	Activity	DT	IT
7.12	De-gas discussion. Review of oven performance on computer system. Review of billet test results: hardness and conductivity		33
8.43	Brief discussion with technical experts regarding new billet size(130kg) and de-gas trial times		14
13.00	Discussion with operator about MA production particularly about re-mill and blending area measures which are going to be introduced. Note (poor communication has caused issues which need resolving)	15	
13.40	Talked to operator about scrap query	4	

Table 15.0 TLA Direct and Indirect Quality Activities

TLA is involved in a project to improve the reliability of a key phase in the production process and elements of it can be seen at 7.12 and 8.43. This role is in addition to the usual job duties and it requires data collection and analysis. At 13.00 there is a reactive direct quality activity which is associated with having to correct a poor communication issue. Again, at 13.40 providing advice about correcting a poor quality product problem is also reactive. Although these activities are only 8% of the TLA's time these are still activities that in an ideal situation should not be necessary.

Team Leader B (TLB) spent the whole time on direct activities, predominantly production orientated rather than the planning, organising and managing element of the role. Only 12% of time was spent on a quality activity, and it was reactive to try to address issues concerned with a negative reaction to planned process improvement changes as shown (Table 16.0).

Time	Activity	DT	IT
8.25	Discussion with Module manager and engineers about blending changes and lack of communication. Manager advised that planned changes/layouts were in canteen and around dept and team were asked for volunteers to join task force.	10	

Table 16.0 TLB Direct Quality Activities

Senior Operator (SO) was the only other person observed participating in indirect quality activities in addition to direct quality activities with examples shown (Table 17.0).

Time	Activity	DT	IT
5.55	Team meeting in canteen. Team leader informed team of situation concerning production, quality, discipline with respect to cleanliness and working, paperwork.		10
6.30	Tidied work area after last shift.	4	
7.31	Went to see Material/Quality engineer and informed him of re-occurrence of the problem. Engineer had told the supplier to correct the problem but this new batch still contained burrs. Engineer visited welding bay to check can burrs.	4	
8.45	Took cans from morning meeting to ultrasonic tank and loaded for cleaning. Note due to poor quality items from supplier	10	
9.04	Removed cans from ultrasonic cleaner	4	
9.08	Meeting about the reorganisation of blending area and planning of weekend work to achieve move.		42
11.05	Unloaded a welded can from workstation. Loaded new can for welding. Inspected, checked for burrs and cleaned with wire brush.	8	

Table 17.0 SO Direct and Indirect Quality Activities

At 5.55 the team meeting can be viewed as indirect as it facilitates teamwork and shares information across the team. Yet this type of activity is intrinsic to the job function at this organisation and not optional, therefore should it be a direct activity? At 9.08 the SO was involved in an indirect activity which comprised a meeting for a one off long term project to improve the layout and organisation of part of the manufacturing area. Direct quality activities are mainly reactive in nature such as 7.31, 8.45 and 9.04 which involve action and correction of supplier product quality problems. At 11.05 the predominant direct task is production focused yet a small element of this activity is self “inspection” of the work that had been performed and this is a positive activity which ensures the product complies to specification and ensures a faulty product is not further processed, but reworked if necessary. Such an activity is intrinsic to the SO role but this may or may not be the case in other roles or organisations.

The detail behind the general statistics concerning the proportion of time spent on quality activities suggests that the categories of direct activity and indirect activity are more complex than originally considered. In fact the detail has shown that even the categories of reactive and proactive (within the direct time category) have not fully articulated all the general types of quality activity that an individual participates in. More specifically the reactive sub category in Direct time has included activities concerned not only with investigating and correcting poor quality, but also activities which ensure that work is being done consistently and correctly in accordance with work instructions and the organisations (best) practice, and also minor improvement activities which are locally controlled and all these were considered fundamental elements of individuals jobs.

In addition the indirect time activity has had very little exposure apart from some “soft” good practices, which at this case study organisation are part of an individuals job and large long term improvement projects which have been categorised as proactive quality activities.

This in depth study has so far found that the contextual data has created a richness and complexity in the task analysis, which the definitions and activity classification framework need to take into consideration.

3.3.3 Stage 3

The analysis in Stage 2 suggests that the current reactive and proactive categories do not adequately cater for the different types of quality activities in which an individual participates. In order to try and find out more detail about the type of quality activity it was decided to compare the quality activities against existing literature and evaluate them from an academically orientated perspective. Therefore the third stage of the data analysis involved examining the quality activities and categorizing them according to the Quality Management Methods detailed by Zhang (2000), using a template analysis approach. Further detail about these quality activities can be found in the Literature Review, Chapter 2. The purpose of this analysis is to determine the general type of quality activities performed and to try and align the real world practitioner based quality activities in the case study to the predominant theory in the literature. Firstly the analysis was conducted on a within case basis, for each individual. Then a cross case analysis of the overall results comparing the types of activity and not the quantity or duration (Table 18.0) has been conducted.

Zhang Definitions	MM	MSE	SLE	PC	TL(a)	TL(b)	SO
Supplier quality management			X				
Process control and improvement	X	X	X		X		X
Product design							
Quality system improvement	X	X					
Leadership							
Vision and plan statement							
Evaluation	X						
Participation					X		X
Recognition and reward							
Education and training							
Customer focus							
Other			X		X	X	X

Table 18.0 Quality Activities performed categorised based upon Zhang‘s QMM Model (2000).

The Zhang (2000) framework and definitions, though comprehensive, could not be used to classify all the quality activities performed, therefore a category of “Other” was added and examples of such activities are shown in (Table 19.0).

	"other" Quality Activities
Senior Laboratory Engineer	Supplier quality-poor product quality, product rectification
Team Leader (a)	Resolving poor communication issues, poor product quality problems, process improvement – data collection
Team Leader (b)	Resolving poor communication issues.
Senior Operator	Supplier poor product quality problem.

Table 19.0 Example "Other" Quality Activities

If the above activities are examined they are broadly associated with the categories of Supply Chain Management, Process Control and Improvement, and Participation. However the Quality Management Methods (quality activities) specified by Zhang within these categories are predominantly proactive and therefore do not reflect the reactive nature of the activities observed. However, the exceptions to this are the MSE reactive activities mentioned earlier which could be easily allocated to the categories of "equipment maintenance improvement" (within process control and improvement category) and "work instructions" (within the quality system improvement category). The SO quality activities concerning supplier problems and the quality improvement project could not be categorised using the Zhang QMM's. But mainly Zhang's classification methodology does not consider the reactive quality activities in which individuals engage but focuses on the positive proactive quality activities. Although Inspection is identified by Zhang as a QMM, there are no activities identified which can deal with problems arising from inspection. Further examination of the QMM categories and quality activities shows that the Process Control and Improvement category was the most frequently occurring which aligns with the Participant Observations taking place in a manufacturing environment. Similarly it is not surprising that the QMM's of Supply Chain Management, Quality Improvement and Evaluation were also detected. All these activities are obvious to the observer, likely to be observed in a single day (as they can be day-to-day activities) and representative of a manufacturing environment. The absence of a design facility in the organisation meant that the Product Design QMM was unlikely to be observed. However the other categories which were not observed or detected in the analysis, firstly appear to be management orientated/strategic in nature or "soft" people-orientated quality techniques and therefore less easy to detect through participant observation and secondly are the sort of activity which may occur infrequently as they are not essential to day-to-day activities.

Finally, this method of categorising the activities was the most time consuming since the analysis process required a match to be found with Zhang's existing detailed list as the categories did not emerge from the data. It would appear that by precisely detailing activities it was difficult to align them with existing literature, firstly because the activities in the literature

are predominantly proactive and very specifically articulated and secondly the literature considered activities that were not operationally orientated.

3.4 Stage 4 Cross case analysis discussion

Given the opposing difficulties in categorising the quality activities in stage 2 (too vague definition) and stage 3 (too limited and specific definitions) a revised method for analysing and categorising quality activities is required which draws on the findings so far. A set of revised definitions is needed to facilitate consistent analysis of the operational quality activities within a manufacturing organisation. These definitions need to reflect the nature of "real-life" day-to-day quality activities performed by a range of manufacturing personnel. Correct categorisation and analysis is the first step towards managing the activities.

Therefore it is necessary to assimilate the conclusions so far in order to be able to refine the definitions and activity classification system framework, by examining the direct and indirect categories in turn.

<u>Direct Activities</u>

Modern job descriptions encourage employees to engage in whatever is necessary to do the job as was the situation at this case study organisation and documented job descriptions that were available specified engagement in Continuous Improvement activities. The observation of a wide variety of quality orientated direct activities incorporated into day-to-day tasks confirmed this position.

Direct quality activities appeared in a number of manifestations such as:

- Inspection, testing, updating work instructions and removing contraband gauges and other similar activities designed to ensure control and compliance to requirements and maintain the existing quality performance.
- Investigating and correcting process problems, notifying suppliers of faulty items, managing poor communication and other similar activities concerned with investigating the root causes of failures and making corrections. These activities are commonly known as "firefighting" and are reactive in nature.
- Preventing problems occurring and introducing improvements such as changing the ultrasonic fluid (SO activity at 8.45). These activities are proactive and improvement orientated.

There is also the issue that some activities can be considered proactive (or best practice) and therefore organisations may or may not participate in them. These activities may start as a

improvement program (such as SPC or 5S implementation) but once adopted and integrated into day-to-day activities then become the norm (such as completing control charts, tidying the work area between tasks). Teamwork and participation activities can also be considered in this manner. This firstly suggests that quality activities may change from Indirect to Direct and secondly it indicates that an organisation may have opportunity to introduce more direct quality activities in order to improve quality performance.

There were no reactive indirect activities identified in this research. This is probably because the definition looks beyond day-to-day tasks which reactive activities tend to be and is looking at quality improvement only which by definition is a proactive activity. Although in the Stage 2 analysis participation and teamwork was originally categorised as Indirect activities, these activities are intrinsic to an individuals day-to-day job and should be considered differently.

The analysis findings suggest that the original Direct and Indirect Categories need reviewing and extending in order to capture the full extent of quality activities that may be encountered within a manufacturing environment. Direct Activities, have been renamed Embedded (day-to-day) quality activities to reflect the fact that these are not only intrinsic to an individuals role but also cover a wide range of quality activities, both reactive and proactive. Indirect Activities have been named Quality Improvement Projects, in order to distinguish them as activities extrinsic to the usual role, and reflect that they are likely to exist as “one off” projects. In order to facilitate recognition of these two distinct categories, their inherent features have been compared (Table 20.0).

Quality Improvement Projects	Embedded (day-to-day) Quality Activities
(formerly Indirect)	(formerly Direct)
Management led, project manager.	Locally led, shop floor / operations managed.
Long time scale.	Short time scale.
May normally require resources from outside departments.	Local resource only.
Large project (with respect to cost &/or time).	Minimal cost / time requirements.
Easy to identify.	Difficult to identify.
Comprises a limited number of activities.	Comprises many types of quality activities.
Done to focus on one specific performance target/goal.	Impacts on several performance measures / targets.
Only proactive.	Can be reactive as a consequence of poor quality.
Tasks in addition to normal job function.	Tasks intrinsic to job.
Can be quality specific or part of organisation wide improvement programme to improve a significant problem.	Used to check/maintain/assess product or process against requirements to maintain current performance. (Failure to do tasks could result in poor quality).
Often technique/tool implementation orientated (e.g. SPC, 5S).	Involves use of known existing tools/techniques to improve or address simple quality problems
On successful completion may lead to day-to-day activities e.g. from SPC implementation to SPC chart completion.	

Table 20.0 Comparison of Embedded and Improvement Project Quality Activities

4.0 Activity Classification System Refinement

Using the previously presented data, revised definitions have been created for the Activity Classification System.

Embedded (day-to-day) Quality Activities (formerly Direct Activities)

There are three main types:

1. Compliance and Control. These quality activities are those that can control the process and ensure compliance to operational requirements. This activity can include for example, inspection, testing, TPM, 5S (e.g. tidying work area), OEE, and SPC (e.g. completing control charts). These activities maintain existing quality performance levels.
2. Corrective Action. These activities arise as a result of defects occurring and are necessary to investigate and correct the initial defect. Such activities include rework, completing concessions/scrap dockets, rejecting/returning goods to suppliers and liaising with defect originators. In addition, more direct quality activities could result from poor communication or a lack of team working.
3. Prevention and Improvement. These activities can contribute to improved quality and are small local-led improvements to process/product achieved through minor changes in order to prevent problems occurring. These may be being performed in order to address local / cell / department performance measures or to overcome a recent poor trend. These activities will require proactive activities and resources (time and money) which are within departmental control. These may lead to a compliance and control activity being introduced and therefore have a direct immediate impact on quality performance or alternatively a larger issue requiring a significant improvement project may be identified.

Quality Improvement Projects (formerly Indirect Activities)

These activities are extrinsic to the normal job function and do not directly contribute to the day-to-day value adding activities. These activities are often managed or led from outside the department and may be part of a larger project. They contribute to improved quality performance in the long term may be as a result of their recommendations or project outcomes. They do not have a direct immediate impact on local quality performance measures.

These revised definitions have been incorporated into the amended Activity Classification Framework (Figure 3.0). Examination of the framework shows that the categories of direct and indirect have been kept so that they can be used to classify non-quality related activities to ensure completeness of the framework. For example, direct (non-quality) activities would

typically involve those activities involved in production or mainstream job description items that are unrelated to quality. Indirect (non quality) activities would again be work related tasks outside of the normal job description, for example, going to a Union meeting or training course.

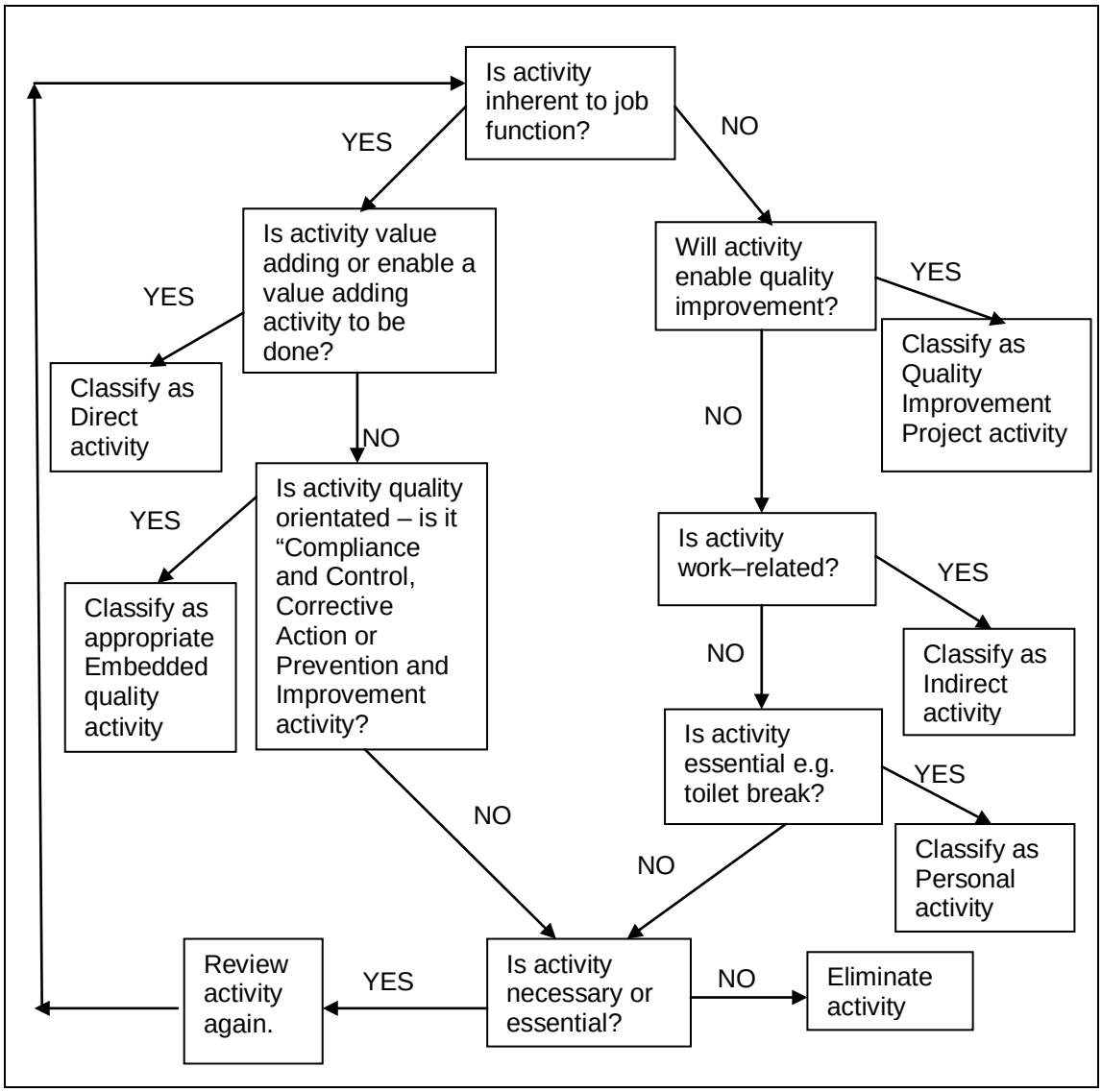


Figure 3.0 Revised Activity Classification System Framework

5.0 Conclusion

This Case Study Report has summarised the research conducted into the nature of employee involvement in quality activities in a manufacturing environment. The findings presented are supported by the Case Study Database. This report also complements Chapter 7 by providing an overview of the analysis performed.